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"Do we have to actually understand all this?" Students' on-line information search and evaluating the sources when working with Controversy Mapping

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Supervisor:	Annika Lantz-Andersson
Examiner:	Ernst Thoutenhoofd
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Abstract

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Aim: The purpose of this thesis is to explore upper-secondary students' information search and their evaluation of on-line sources in a project work on socio-scientific issues when controversy mapping as a new digital method is implemented in the assignment. Accordingly, the focus of this study is on how students manage on-line information search and how they evaluate web-sources by relating these to their learning activities with specific socio-scientific issues.

Theory: The current study draws on *sociocultural traditions* on learning (Vygotsky 1978), by which learning is understood as emerging through interaction with other people and with the tools available in the activity and embedded in the specific context of every specific *situated* practice (Säljö, 2000). Therefore, an important theoretical aspect of this thesis is how knowledge is *mediated* by communication and by the use of *tools* and how this interplays with students' learning.

Method: The current study is conducted as a qualitative case study, and the collection of empirical data consists of video-recorded activities of upper secondary students' work at a Swedish school. The video-recorded data is analysed by *interaction analysis* (Jordan & Henderson, 1995). Interaction analysis implies studying the moment by moment interaction in detail, including the students' talk, gestures etc. and their use of the applied tools.

Results: The findings of the study show that the use of controversy mapping for searching and evaluating on-line information sources entails a very complex process because it implies open-ended information with many contested aspects of particular socio-scientific issues. Although the activities become rather challenging for the students, the tools do open possibilities for learning and new ways to visualize and articulate science. Moreover, working with controversy mapping demonstrates significance in its contributions to students'

information literacy, and to their awareness about users' individual input when working with digital tools.

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Gothenburg, May 2016

Réka Izabella Csonka

Contents

Abbreviations

SSI – socio-scientific issues

ICT - information and communication technologies

IA – interaction analysis

Introduction

One of the greatest challenges of today's digitalized society is to find, to analyze and to critically evaluate information (Swedish Media Council, 2015). Taken that the Internet is the most common and most accessible platform, we navigate this constantly growing sea of information in our daily routines. This navigation becomes even more significant in a time when dilemmas, debates, and conflicting views in a number of social, political and economic matters (e.g. migration, global warming, etc) concern communities of people worldwide. In other words, this is an important part of upper secondary education, where learners entering young adulthood need to understand issues that include open-ended problems of scientific, moral, economic and political character, so called socio-scientific issues, to be able to participate in society as active citizens (Sadler, Barab, & Scott, 2007). Based on this argument it is important for schools to deal with controversies in a democratic society in order to understand the possibilities and constraints that these imply for everyday life. According to Dewey's (1929) pragmatic vision on learning, young learners' participation in society should be treated as a major aim of education because it contributes to a democratic and progressive society. Moreover, he argues that "the ethical responsibility of the school on the social side must be interpreted in the broadest and freest spirit" because this way the child "may not only adapt himself to the changes that are going on, but have power to shape and direct them" (Dewey in *Hickman and Alexander*, 1998, p. 247). This aspect has inspired my background interest in the current study where the issue of dealing with controversies in present-day educational practices is important for learners to understand their implications in the everyday lives of citizens and to be able to actively participate in society.

Additionally, the appropriation of new digital tools for information search in education is significant because it contributes to the field of knowledge on how students evaluate information by managing a variation of sources on-line with the help of technology. Firstly, this field of research is important for schooling because the expansion of information on the Internet and the development of technology place new demands on both teachers and students today. Secondly, an important relevance of the current study is that socio-scientific controversies are global concerns that interplay with people's everyday life all over the world. Health-related questions, human impact on climate change, individual and national responsibilities in global economy, etc. bring forward the necessity of informed and active roles of citizens. Moreover, education needs to support students with decisions about various aspects of using web-sources, such as: How deep to go in web-based information sources?

What types of on-line sources ought to be credited, omitted and why? Such questions are important because students are expected to be able to validate sources for their learning, which implies that information retrieved from the Internet need to be assessed in relation to if it is trustworthy and how valuable it is in relation to the problem at hand (cf. Skolverket, 2011; Skolverket, 2013).

My study aims to contribute to knowledge in the field of information literacy and how students evaluate sources by studying a Swedish context, where the use of digital tools is implemented in a school assignment involving searching for information on controversies on the Internet.

Literature Review

The use of controversy mapping in science education is a rather new method and therefore, the field of knowledge is relatively unexplored. Controversy mapping is regarded as a combination of science, technology, digital inquiry, project work and information-search (Venturini, 2012). In other words, the focus of research in this field is on students' appropriation of a complex method and on students' understanding of how scientific knowledge is constructed. Taken that controversy mapping involves elaboration and collection of on-line information, adjacent field of research such as *information search* and *learning and IT* could form the background knowledge. With a similar theoretical background as the current study, research studies in the field of information search that imply online search and learning and IT in a school context are often intertwined. More specifically, such research includes notions as for example *information literacy* (e.g. Limberg et al, 2008; Limberg et al, 2013; Sundin et al, 2011) and *digital literacy* (e.g. Gui & Argentin, 2011; Lemke, 2006; Ribble, 2007) that become parallel concepts with many similar components.

Although the primary focus of the literature review for the current study concerns the search and the evaluation of information on web-based sources along with implications of digital literacy for learning, in order to provide a better understanding of the larger context for research in science education, a brief overview of research on *socio-scientific issues* (SSIs) will also be presented. The importance of this relates to the increasing amount of social and political issues with scientific nature, so called socio-scientific issues (e.g. health-care, environmental and climate-related questions, global economy or war-fare, etc.), which have come to be regarded as major global and local concerns of society in the 21st century, and inevitably, they have become current topics within science education as well (Sadler, 2011). Therefore, socio-scientific issues have specific significance in a context where digital tools

are implemented in the learning activities, which are also emphasized by the Swedish National Agency for Education (Skolverket, 2011). The national curriculum for Swedish upper secondary education specifies the aims of the school subject: Social studies, where for instance it is formulated that students should be able "to analyze and to criticize local, national and global social issues from different perspectives" and "to search information about society from the media, the Internet and other sources, and to evaluate their relevance, as well as their trustworthiness" (Skolverket, 2011). Accordingly, students are expected to critically examine and evaluate various sources and to be able to orient in a complexity of information which is under rapid change.

SSI-projects, also called Nature of Science (NOS), are often interdisciplinary research that explore students' development of science literacy (e.g., Feinstein, 2015; Kolstø, 2001; Sadler, 2011). Research studies in this field have found that understanding the social aspects of science, i.e. science in social contexts, enables the students to practice a critical attitude and it challenges their ability to evaluate science information in the media (e.g. Leung et al, 2015; Molinatti & Simonneau, 2015; Simonneaux, 2008). Moreover, research has indicated that discussions on SSI help students develop their argumentation skills and enhance their scientific knowledge and its social implications for citizens (e.g. Christenson & Rundgren, 2015; Khishfe, 2014; Rudsberg & Öhman, 2015). According to Christenson (2015), SSI argumentation may also function as a tool for teachers to identify quality indicators (i.e. the components of an argument), which can enhance assessment.

Säljö and colleagues (2011) emphasize the significance of challenges implied by the use of the Internet to learn about SSIs. This means that using the web to search information and learn about SSI becomes even more complex, and knowledge about information search and source criticism must be included in such activities (cf. Skolverket, 2013; Tallvid, 2015). Furthermore, working with SSI as open ended tasks, entails that the students are challenged by the problem-solving activities (e.g. Christenson & Rundgren, 2015; Settelmaier, 2003).

On-line search and learning and IT

As noted above, the expansion of the Internet has resulted in the fact that information search in schooling often means online search. For this reason, researchers in library and information science, for example Gärdén, & Francke (2013) argue that terms, such as information literacy, media literacy and digital literacy cannot be separated because they share a common ground in school practice, and are often used interdependently. Therefore, it is

rather difficult to treat these terms per se, all the more, that they involve interrelating aspects, such as searching strategies, evaluation of sources, source criticism, and so on. Nonetheless, despite that the terms are intertwined, in the current study I will try to frame the literature review by starting with a research background on information literacy, and then continue by expanding it with the field of learning and IT, which comprises studies on digital literacy as well.

In the past decade many studies, both in Sweden and worldwide, have dealt with students' information search in schools. A majority of such studies have focused on information searching on the Internet, and thus, can be regarded as valuable background for this study (e.g., Gärdén et al, 2014; Lilja, 2012; Limberg, 2013). One of the most prominent researchers to establish the academic discipline Library- and Information Science (LIS) in Sweden, Louise Limberg defines and formulates information literacy in one of her latest publications (Limberg et al., 2013) as consisting of information searching, navigation on the Internet and the critical evaluation of information sources. Sundin and Francke's (2009) continue to conceptualize information literacy in its context by arguing that:

> "from a socio-cultural point of view, information literacy is embedded in the context in which information practices are carried out, rather than consisting in a fixed list of context-independent skills or individual cognitive capacities" (par. 8).

In other words, information literacy is a terminology with a very complex and diverging meaning. Among others, the seeking and the validation of information is conditioned by the context of activities, which, in the sociocultural perspective can be seen as a form of situated learning practice (Säljö, 2000).

In an early study which focuses on information literacy in a school context, Limberg and colleagues (2008) discuss how secondary school students' in grade 8 search and use information for their learning assignments, which include various tools of information and communication technologies (ICT), such as the Internet, web-sources, computers, but also books and pictures. The focus of the study by Limberg et al (2008) is on *what* and *how* students learn from information search, and it emphasizes the importance of information literacy in how students build knowledge, and how they understand complex contexts. The findings show that critical evaluation of sources play a crucial role in how students engage in the particular writing topics. Another interesting finding of this research is that the skills employed in students' information search imply a far more creative complex process

"involving time, thoughts, emotions and actions" (p. 14) than just the mastering of digital tools. In other words, the results show that the difficulties students encounter during information search such as selecting or handling information overload, or validating source-relevance are not facilitated by their digital competences (e.g. the ability to handle ICT, critical knowledge through ICT, skills to use computers to find, to evaluate or to exchange information).

In another earlier study within the field of information literacy, a project on students' learning through school libraries showed that information search and the processing of information are linked to students' knowledge building, and that their web-searching strategies are determined by looking for facts (Alexandersson et al, 2007). According to Alexandersson et al (2007), students tend to adopt an attitude "to find the right answers" during their information search. Alexandersson and colleagues (2007, pg. 12-14) study discuss that the *evaluation of information* occur on different levels, such as external or internal ones. External evaluation means that the learners evaluate validity of a source, while internal evaluation implies that they judge its content along with its relevance for the particular aim of their task. Internal evaluation is defined as "the applicability of a source in relation to the task or to the problem which the retrieved information is meant to expose" (Alexandersson et al, 2007, p. 14). Evaluating trustworthiness of information concerns issues related to *source criticism*, which is another central aspect of information search. Alexandersson et al (2007) emphasize that students who are deliberately doing source criticism focus on actors behind the text, whose interest the text may represent, and if the text is adequately suitable for what is already know about the particular matter.

Several other studies have treated the ways by which students assess credibility of sources, which is an important part of information literacy. A study by Lundh and her colleagues (2012) explored how students describe themselves as information seekers in a school context where their narratives as assessed and graded. The research method consisted of analyzing blog posts on credibility judgments written by 28 students at a Swedish upper secondary school. The assignments required students to work in groups to search information about a controversial issue, to identify sources, and to agree on a list of 12 labeled as trustworthy sources. In other words, this was also an example of how credibility judgments were negotiated in discursive interaction. Based on a sociocultural perspective, the results showed how the group of students had learned to participate in the social activity of working with evaluation of sources, and also how they dealt with the assignment when interacting through their blogs. Another finding was the tension between the description of the individual

information seeker and the description of the good group member. The researchers argue that ”the critically aware information seeker (…) is someone who can demonstrate independent thinking and make independent and individual credibility judgments, but also someone who has understood the expectations on what the appropriate ways of seeking information are” (Lundh et al, 2012, p. 15).

Another study, by Francke et al (2010) examined the ways in which students assess the credibility of sources that they had used in school during the use of various “participatory genres”, such as on-line encyclopaedias like Wikipedia, Greenpeace’s website, or political blogs, etc. As a peculiar feature of their analysis, validation of sources was also considered by comparing print and digital media; nonetheless, this aspect is not so much relevant for the current study. This ethnographic study conducted in a sociocultural perspective involved in-class project work of students from an upper secondary school in Sweden. The assignment was to find 12 sources dealing with the expansion or the elimination of nuclear power in Europe and to rank them according to their credibility (Francke et al, 2010, p. 679). Among other aspects, students investigated author and actors behind the source, as well as intention and timing (why and when source was created). The findings of the study indicated that many students engaged in finding facts in their information search because “facts were generally perceived as statements about how the world ‘is’ “ (Francke et al, 2010, p. 691). Another result concerned neutrality, which proved to be “a question of balancing different viewpoints rather than presenting something as an indisputable fact” (Francke et al, 2010, p. 687).

Known for his numerous research studies on information and library science, as well as information seeking, Marchionini (2006), underlines that the growth of the Internet into a mass medium has posed a constraint on its users to refine methods for selecting, navigating of finding information. He refers to the process with the term “information retrieval”, and categorizes searching strategies by distinguishing exploratory search or browsing strategies (e.g. clicking to embedded links, phrases, open new pages within a page) from fact retrieval or analytical strategies (e.g. using keywords to retrieve information).

The students’ focus on finding facts as shown in Alexandersson and his colleagues (2007), parallels findings from later studies. Such research has pointed out that when students are doing web-search during school tasks they have the tendency to search for fact-based information for their learning assignments (Gärdén et al, 2014; Lilja, 2012). In a study by Gärdén and her colleagues (2014) researchers looked at how students at various school years in Swedish institutions conceptualized the term ‘facts’ in their use of information during school assignments. The results of this study show a categorization of how students interpret

the meaning of ‘facts’ in their search and use of information for writing school reports. Accordingly, the study shows three alternatives on how students view facts: as “specific genres or modalities”, as something evident and distinguishable, and as strongly connected to neutrality (Gärdén et al, 2014, abs.). Limberg (1999) calls the process of searching for facts as ‘fact-finding’, to find answers that are already determined. Moreover, according to Limberg this activity implies two aspects: a) that students relate various sources to each other, and they try to create meaning from them, and b) develop a critical understanding of the sources in relation to the topic, which is often part of the learning outcome. Another study by Lilja (2012) explored how upper secondary students at a Swedish school contextualized facts in their negotiations of inquiry-based assignments. His results show that students tend to use the term “facts” for finding simple information with the help of keywords, and that they use the notion “deeper knowledge” when they begin to deal with more sources and more complex kinds of reasoning.

Research on learning and information technology (IT) has revealed interesting findings on how digital tools can support students’ learning process (Alexandersson & Limberg, 2012; Selwyn, 2012; Säljö, 2010). An article by Alexandersson and Limberg (2012) presents findings from a series of research studies on the ways in which learning occurs when students search and use information with the help of information and communication technologies (ICTs). Accordingly, they claim that the new digital tools which ”mediate information seeking and learning change the conditions for learning itself” (Alexandersson & Limberg, 2012, p. 131). Selwyn (2008) argues in similar ways and proposes the importance to consider what is actually taking place when technology meets classroom i.e. exploring “educational technologies from the lived experiences of those using (and those not using) them” (p. 83). In addition, Säljö (2010) accounts for the implications of technology in education, since producing and reproducing knowledge by technology has become an important part of the learning process. He argues that the function and role of digital tools become crucial, as they affect “the manners in which society builds up and provides access to social memory, that is, the pool of insights and experiences that people are expected to know about and to make use of” (Säljö, 2010, p. 55). These results indicate that digital tools mediate knowledge content in new manners, which interplay with the possibilities for students’ to critically understand information and develop as enlightened citizens in a digital society.

Additionally, it must be emphasized that critical thinking and the aptitude to use information from a digital landscape have significance at a larger scale because both challenge our understanding of how human learning is constructed by means of technology.

Ribble (2007) defines digital literacy, i.e. the ability to read with meaning and to know how to use technology appropriately and responsibly. A relevant background for the current study is also the way Lemke (2006) defines and specifies digital literacy and calls it 'multimedia literacy'. He elaborates on this term as an important stance toward information sources in the process of learning. He explains that the meaning-making of on-line information occurs as we search on the Internet, and he refers to web-searching activities as "traversals" or "trajectory across links" which involves various types of web-sources (e.g. commercial sites, search portals, personal homepages, data bases, etc.). Lemke (2006) argues that "we do not just surf within Web sites; we increasingly, perhaps normally, surf across sites, and therefore across the Web-genre conventions of different institutions" (p. 6). Buckingham (2006), a pioneer in the development of new media literacies emphasizes "the new ways of mediating and representing the world, and of communicating" through various forms of media, such as the Internet, computer games, mobile phones, etc. (p. 265). He argues that if teachers want to use media in their education, they must become acquainted with them, because students use them as "cultural forms". In other words, they are integral part of learner's experiences of technology outside school. Additionally, in his approach to digital literacy, Buckingham (2006) refers to searching on-line (or information retrieval) as "a functional skill by nature", which he argues that students should learn to be able "to locate and select material – how to use browsers, hyperlinks and search engines, and so on" (p. 268).

In the light of earlier research, it becomes interesting to explore in what ways students make use of digital tools in their information search and in their evaluation of web-sources when working with controversy mapping. Overall, most of the above reported studies have examined students' information search on the Internet. However, there is still a need for research to study how students navigate their way through different arguments on-line, and how they actually evaluate sources with the help of specific digital tools. The current study intends, therefore, to make a contribution to this field of knowledge.

Aim and Research Questions

The general aim of this thesis is to explore upper-secondary students' information search and their evaluation of on-line sources in a project work on socio-scientific issues when controversy mapping as a new digital method is brought into the assignment. The specific focus (illustrated by the excerpts in the *Findings* section) is on how students a) perform on-

line information search, b) make sense of and evaluate the sources and c) how the different searching strategies interplay with their results.

In the view of this, the following research questions have guided my study:

How do students manage online information search?

How do students evaluate web-based information sources and how do they relate their validation to learning activities with specific socio-scientific issues?

Theoretical Framework

The study is based on *sociocultural traditions* on learning (Vygotsky 1978). The sociocultural theory is grounded in European and Slavic traditions, such as the so-called Trojka with Vygotsky and his followers: Luria, and Leontiev and Bakhtin's dialogical perspective (Stetsenko, Arievitch, 2004, p. 71). Vygotsky's (1978) main focus is on the role of everyday communication, i.e. how we become enculturated human beings and the role of language in learning activities.

In the view of the sociocultural perspective, learning is understood as emerging through interaction with the tools available in the activity and embedded in the specific context and culture of every specific *situated practice* (Säljö, 2000). In other words, the appropriation of tools need to be studied in the context in which they are used in order to develop knowledge about their implications for learning. Moreover, in educational research underpinned by sociocultural perspectives the aim is to study how knowledge is *mediated* by the use of *tools* and how this interplays with students' learning. In the Vygostkian vision, tools are often referred to as *cultural tools* (e.g. the use of language), which alter the way we think, learn, and act (Vygotsky, 1978). Learning is then understood as mediated through the use of cultural tools such as writing, spoken language and various physical tools. Thus, tools shape our activities and interplay with or mediate the way we learn. On the relationship between digital technology and learning, Säljö (2010) argues that the use of new technological tools not only support learning in different ways, but they also transform the ways we learn along with our view of knowledge. He also suggests that the development of technology practically changes our interpretations of what learning is along with "our expectations about what it means to know something" (Säljö, 2010, p. 56). These views bring forward the performative and transformative nature of learning and knowing through the use of digital technology. In other words, when we use technology, learning becomes different because the different digital tools change the way we access information and what we need to memorize. For example, this is

clearly visible if we consider portable PCs, omnipresent smart phones, or OneDrive, Dropbox, iCloud as the most common external memories and on-line storage platforms of our every-day life and in today's educational practices. Evidently, the Internet is the main source for information-search today where learners can perform tasks, which imply finding various types of sources with information.

From a sociocultural perspective development and learning is understood as taking place through social interaction on two levels: interpersonal, i.e. through interaction with others and intrapersonal, i.e. through individual reflection (Vygotsky, 1978). This means that learning can be studied by the way people interact and act with one another. By that it is possible to address the research questions of the current study.

Research Design and Methods

Case study as a research design

This study is conducted as a case study. According to Bryman (2012) a case study is a research design, which implies detailed analysis of a single case taking specific interest in understanding activities and their meanings in specific context. Furthermore, as explained by Cohen, Manion and Morrison (2008) the purpose of case studies is to "portray, analyse and interpret the uniqueness of real individuals and situations (…) to present and represent reality" (p. 129) by focusing on specific phenomena involving individuals, groups, roles, situated instances, etc. Many studies have considered the strengths and weaknesses of case study design. Adelman and Jenkins (1980) and Nisbet, Kemmis and Watt (1984) summarize the most important ones. The main weakness is argued to be the difficulties of generalizing the results on a large scale and that findings could open up for alternative interpretations. On the other hand, it is maintained that the strengths include that empirical material of case studies is usually very rich and descriptive, give a rather realistic view of the situation, and can allow generalization about situated activities (Adelman et al., 1980; Nisbet & Watt, 1984). Eisenhardt (1989) describes case studies as research methods aiming to understand the dynamics of situated settings, which is in accordance with the aim of this study.

'Controversy mapping' as a method for digital inquiry

Inspired by Dewey's (1929) vision of knowledge, learning and politics, 'controversy mapping' is a relatively new digital method spreading in educational systems in Europe (Latour, 2004). *Controversy mapping* in the research project within which this master thesis is

set, is an activity where socio-scientific issues (SSIs), as a phenomenon in science education are examined in order to understand their implications in the everyday lives of citizens. The notion 'socio-scientific' implies social, ethical and cultural aspects of topics from different scientific fields. Concrete examples of controversies in relation to SSIs can be: dilemmas on vaccination, animal testing in medicine, genetically modified organisms, or recycling of electronic waste, which are a few of the many current issues which raise debate in society at a global or local level. The 'mapping' is a method to identify and find polemics or debate surrounding a scientific issue. Additionally, 'to map' –in the context of the students the current study has followed– means to use different tools to visualize the problem and its complexity. The focus in controversy mapping is essentially on how scientific knowledge about social dilemmas is created in a world of digitalized information. In line with Dewey's principle (1929) of learning experience and active participation in society this implies that digital tools function as instruments that facilitate public involvement in deliberations of present-day socio-scientific concerns which are part of the everyday lives of citizens. Furthermore, the newness of controversy mapping is based in the fact that it provides the possibility to access and to map controversies with the help of digital tools.

Initially used as a social scientific research approach, controversy mapping as a new digital method emerged in the 2000s (Venturini, 2009), and only later was further developed with a pedagogical purpose by researchers from France and Italy. The link between controversy mapping and the current master thesis is that the empirical data which is analyzed was collected in a research project called "Learning to engage with science and technoscientific issues in a digital landscape: The arrival of controversy mapping as a method for digital inquiry in Swedish upper secondary school"[1], funded by the Swedish Research Council, and supervised by project leader Åsa Mäkitalo, professor at the University of Gothenburg, Department of Education, Communication and Learning (IPKL). One of the major aims of this research was to introduce controversy mapping as a new digital method for visualizing scientific controversies and as an alternative project work for upper secondary students. Another important objective was to examine what the digital tools of controversy mapping enable and constraint as they enter into established school practices in Sweden. Last but not least, the project aims to reveal how this new method challenges students' digital practice and competences in the course of web-search, group discussion, written- and oral presentation, and classroom debates. My position in the project is as assistant researcher, and I joined the

[1] Swedish title: Att kartlägga vetenskapliga kontroverser med digitala metoder: studier av 'controversy mapping' och gymnasiestudenters lärande om sociovetenskapliga frågor

group in September, 2015. The main tasks I have been entrusted with concern: the construction of literature review of the field, technical assistance in video-recording class-room sessions, logging of the collected data. The research project consists of different study phases and data collections. The current master thesis uses documentation from this project, and it involves situated activities of upper secondary students' work. A detailed description of these activities will be presented in the subsequent section *Setting, participants and student assignments*.

Video documentation as a method to accumulate empirical data

In my study the research method of collecting empirical material consists of video- and audio recordings of upper-secondary school lessons. Video-documentation of data implies the possibility to study the students' in situ interaction with each other and with the digital tools. Thus, video recordings as the means of data collection enable scrutinizing instances of interaction (Jordan & Hendersson, 1995; Plowman & Stephen, 2008). It is, however important to recognize that the video-films are not neutral documentation of events but are selected section of activities. Therefore, there are some useful principles for using video as a source of material for research to take into consideration. One such principle is highlighted by Plowman & Stephen (2008) is the aspects of decision-making by which researchers select or exclude data from video resources and privilege "different modes of communication, thereby presenting different perspectives on 'reality'" (p. 542). Thus, it is important to bear in mind that the camera only record specific angles of activities, decided by the researcher deliberately or unintentionally. It is further argued that the limitations of these aspects are their very instantaneity, namely that the focus of attention that may arise on the spur of the moment. This may imply misjudgments of occasionally omitted moments, which cannot be recaptured. On the other hand, Plowman and Stephen (2008) emphasize that the videos consist of more richness in data compared to questionnaires or interviews, as they unfold aspects of social life, and therefore, they include the potential for a more extensive view of the obtained results.

Another important aspect, which has been considered in the use of video recorded data for the current study, is that it enables the documentation of both verbal- and non-verbal interaction along with important details about the individual or collaborative activities that occur during the learning practices.

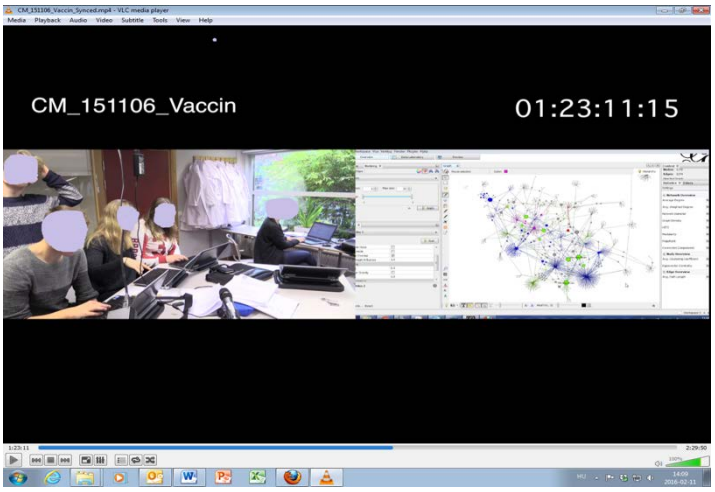
Analytical approach

The analysis draws on Interaction Analysis (Jordan & Henderson, 1995). Interaction Analysis (IA) is a method for studying how the participants in an activity make use of the various resources that are available in the context they act. This method lends itself to analyses that include participants' utterances, actions and events in the activity in relation to the tools at hand, which makes it suitable for the analysis in this study.

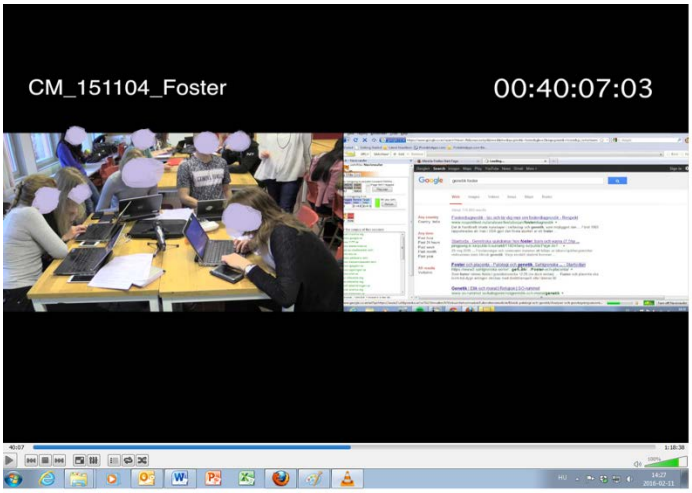
Interaction Analysis (Jordan & Henderson, 1995) is based on ethnography, especially participant observation and harmonizes with the objective of this study to explore upper-secondary students' in situ information search and discussions concerning evaluation of on-line sources. As defined by Jordan and Henderson (1995), Interaction Analysis "investigates human activities such as talk, nonverbal interaction, and the use of artefacts and technologies, identifying routine practices and problems and the resources for their solution" (p. 1). In the analysis I have endeavored to closely focus on what the students actually said and did to avoid ungrounded speculations about what the participants may have thought or intended.

However, as I mentioned earlier even if the video recordings enable this close and detailed analysis of interactions and activities that actually took place, it is important to consider that the films as such cannot be regarded as neutral data. The focus of the camera is determined by the researcher and is important to note that the video recordings only represent a part of the activity. This limitation was considered during data management (collection and analysis) in the current study, and additional support was implemented. For example, apart from the two cameras that were set up to record the classroom activities, a screen recording program, called *Screen-O-Matic*[2] was activated also on students' laptops (one student per group in the small groups). This way, the complexity of students' interaction (in the group, among themselves and with the tools of controversy mapping) was expanded, as not only the activity within the group had been captured, but the individual use of the digital tools was also documented. Moreover, after the data was collected, the videos were synchronized so that the group was visible side-by-side with the screen. To simultaneously see what students are actually doing with the tools as they interact in their groups facilitated the analysis.

[2] https://screencast-o-matic.com/home



Picture 1. Students sitting in group and working with Gephi
(the map itself is captured by Screen-O-Matic)



Picture 2. Students sitting in group and doing web-search by using Navicrawler
(Navicrawler on the right is captured by Screen-O-Matic)

The video recordings thus serve as valuable empirical material for studying learning activities with an emphasis to "overcome gaps between what people say they do and what they, in fact, do" (Jordan and Henderson, 1995, p. 12). Furthermore, Interaction Analysis "replaces the bias of the researcher with the bias of the machine" (Jordan & Henderson, 1995, p. 13). This implies that the process of recording data is mostly automated and it also captures close details.

Therefore, interaction analysis of video-recordings can be considered of a higher degree compared to other methods e.g. field notes, observations and interviews that rely on "reconstructive bias of individual researchers" (Jordan & Henderson, 1995, p. 13). In other

words, the exact same data in exact same form can be viewed and re-watched as many times as needed, in contrast with other ways for collecting, analyzing and storing data.
Arguably, interaction analysis of video-recorded material is also a subject to the limitations of technology. For example, we need to take account of unpredictable malfunctions and consider measures by which we can avoid unfortunate situations that may cause severe damage for the research project, for example, by using more than one camera for data collection, multiple storage devices of the data, etc. As argued by Jordan and Henderson:

> "One reason for relying on video, then, as the preferred kind of data for our analyses is that we would like our theorizing to be responsive to the phenomenon itself rather than to the characteristics of representational system that reconstruct it and thereby constrain the direction of analyst's thinking" (1995, p. 14).

This argument suggests that in spite of the bias that the camera implies the limitations of the video can be overcome by its compatibility for research. More specifically, this method enables the researcher to come as close as possible to the activity at focus. This also means that video-recording may be brought into compact relation with the research interest, and bears the potential to reveal how it works in action. As a contrastive example, field notes or interviews or other methods would provide a different angle for the research.

Another important aspect shown by the analysis is the manifestation of non-verbal interaction of the students. Some of the most common non-verbal interactions which occur in students' interaction are: making quotation marks in the air, facial expressions that are implicit in students' behavior, shifting intonation during verbal utterances, or finger pointing on the screen. In other words, non-verbal interaction is an important part of working with tools (e.g. pens, digital tools, printed maps) in order to make meaning of the particular socio-scientific controversies, and to convey an understanding of it.

Logging, analyzing and transcription of data

The recorded content logs have been expanded into transcriptions and the analysis of the data was done in the original language. Translation from Swedish to English was done as close as possible in the light of making sense of the dialogues and in order to approximate an authentic youth language/slang. The original transcriptions in Swedish are included in the *Appendices* section of the current study.

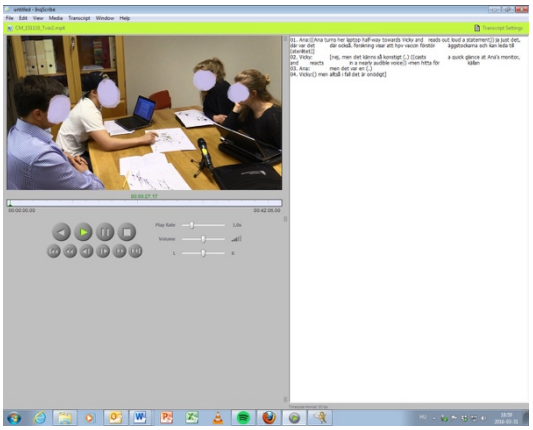
The transcripts also signify a base for Interaction Analysis (Jordan & Henderson, 1995). Annotations of nonverbal behaviors, such as gestures, intonation, object manipulation, are

also included in the transcription. The transcriptions have furthermore followed some of the conventions of conversation analysis suggested by Hutchby & Wooffitt (1998). A transcription legend of the applied keys is attached in the *Appendices* section of the current study.

Upon logging the data of the recordings the first selection was done by searching for instances where the students clearly used the digital tools in their interaction with on-line sources. These instances involved, for example: digital operations, such as mapping, web scraping, selecting, ordering and visualizing digital data on a controversial issue, but also activities related to printed resources, such as making notes on the printed maps, reading instructions on paper form etc. More specifically, the search was conducted by focusing on the participants' way to navigate their way through a "sea" of different websites, how they used the digital tools for mapping the controversies, how the students interpreted information from different sources, and what challenges they encountered when trying to evaluate relevance of on-line sources. The result is presented as an ethnographic narrative with selected excerpts. The aim with selecting a few excerpts was to provide a more in-depth illustration of concrete instances of students' information search and evaluation of sources by using the tools of controversy mapping in their learning activities in class. The selected three excerpts are empirically generated, i.e. they represent common instances in the material as a whole. Additionally, the principle of choice for the particular excerpts was to find illustrative examples of how students deal with the digital tools in their on-line information search and how the significance of the applied searching strategies is represented in relation to the results of the assignment. Moreover, this focus that has driven the selection of data is also due to the fact that I have seen their importance in the large empirical material as a whole. Accordingly, these phases of students' interaction with web-sources are not only crucial for the results made visible by the printed maps, but they also say a lot about how students manage seeking and validating information in order to understand the controversies about the particular socio-scientific issues. Thus, my choice of the chosen excerpts serves also as exemplifying events of importance in line with the focus of the current study.

Consequently, the empirical examples show recurring pattern of the activities regarding the students' on-line information search and how they discuss the evaluation of the sources. The transcription included re-watching and re-listening of the video-recordings. In order to

facilitate the listening and typing operations, the video files were opened with the help of a transcription software, called Inqscribe[3].



Picture 3. Using Inqscribe for data transcription

The analysis included going back and forth over the transcribed excerpt (one at a time), and searching for patterns within the sets of data. (For example, the focus of the students' work when finding information, how they decided on what sources to use, what made them satisfied in their information search, what criteria did they use when they discussed validity of the sources etc.) During the course of this analytical procedure, my initial participant observation from the recordings in-class served as support since I had gained a real-time experience of the group interactions captured by the camera.

Ethical considerations

The research follows the ethical code of the Swedish Research Council (Vetenskapsrådet, 2011). It applies for all research studies in general and ensures that individual integrity of participants should always be respected. Since participant observation, video recordings, and audio recordings are used, ethical considerations require even more exquisite attention and awareness concerning participants' integrity.

Additionally, information about the study was provided by researchers of the LETCOM project both in written form and through oral presentations for the participants. Considering the fact that the project involves a group of students and teachers in a school setting, in order to proceed with the research the project required the consent of the school management. For this reason, the research project was introduced to the school principal, and additionally, the research group consulted with some teachers from the school and with the students

[3] https://www.inqscribe.com/

themselves in form of workshops and meetings. Moreover, a pilot study had been done earlier with two of the teachers. Thanks to this, the school became a candidate for the controversy mapping project.

One of the teachers who was the initial contact person at the school, accepted to undertake the involvement of the school principal first in order to get support in resources and for the course of the project. The project manager (from the University of Gothenburg) and the school principal made the necessary arrangements to proceed. Last but not least, the appointed participants were asked for their approval by providing them with printed documents to sign. Two types of consent forms have been provided for the participants: one template for the teachers and one for the students, in line with the ethical considerations of the Swedish Research Council (Vetenskapsrådet, 2011).

In short, both students and teachers had been informed through workshops in several occasions about the significance and the purpose of the project in a presentation held by researchers from the University of Gothenburg. These workshops had been organized in collaboration with local teachers in 2015. The first workshop was held for students in June, 2015, in order that they become somewhat acquainted with the tools. A researcher from the University of Gothenburg and one of the teachers at the school had introduced the project for the same group of students who participated in the project in the fall. A second workshop, specifically for the teachers, was held in August, 2015, with the aim that they also become familiar with the tools. All teachers in the school's science program were also introduced in detail to the project, and this included approximately 20 people, from athletics teachers and those who actively participated later in the project. The last workshop took place approximately one week before starting the project and the actual work with the digital tools for controversy mapping, and the focus was on technical aspects and on the privacy of data management. A researcher from project and a person from the IT faculty at the University of Gothenburg had one and a half hours long drop-ins on two occasions for the students to make sure that the programs were running properly on all PCs and MACs. As they have encountered some problems with the running of one of the tools and the new version of Java, installations were made.

Furthermore, as emphasized by the Swedish Research Council, data anonymization ensures that the link between samples or obtained answers and individual participants is eliminated, so that no unauthorized access can restore it. In other words, this excludes the risk of the possibility to combine, for example, a specific task with a specific individual's identity. In the view of this, the confidentiality of the empirical data was underlined both orally and in

writing for the attendants. Thus, all participating students and their teachers are treated confidentially in the study, which means that the names used are fictional. Additionally, it is important to note that the video data are kept in secure places, and stored by the University of Gothenburg on hard-disks which are locked with secure codes.

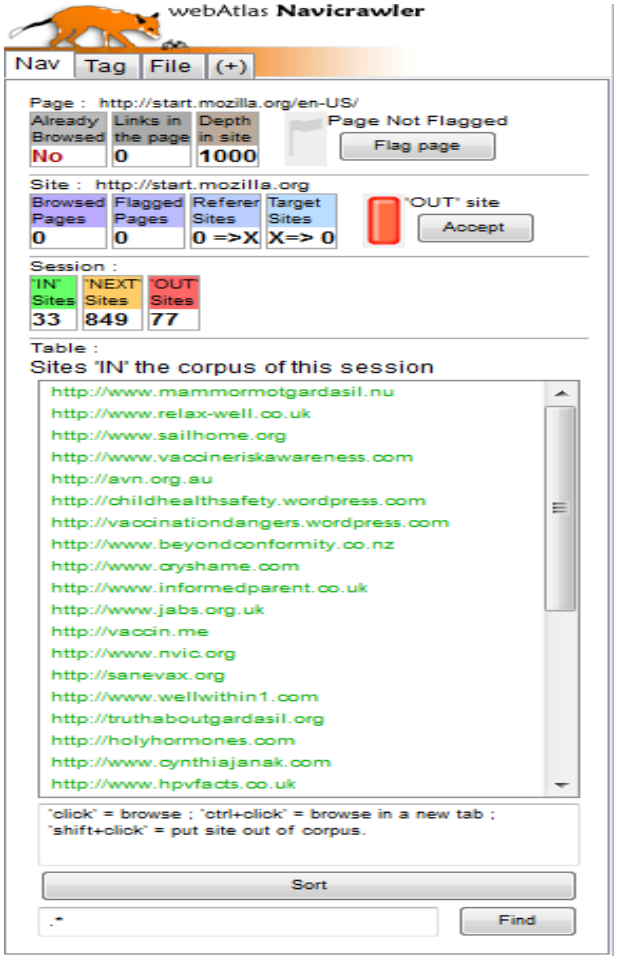
Setting, participants and student assignments

The video recordings were carried out at an upper-secondary school in a major city in Sweden, involving students from second year of upper-secondary school, over a period of two-weeks, comprising 3 days per week and approximately 18 hours of filming during the fall semester of 2015. Although the entire class participated in the project by using the implemented digital tools, about 11 students agreed to be video recorded. Two cameras had been set up in the classroom. The participants of the video-recordings were assigned to groups of 4-5 students, sitting around a large common table, each student working from his/her own individual laptop. The digital tools in use (*Navicrawler* and *Gephi*[4] - description on pages 20-21) have been installed on students' laptops prior to their use. This implied a preliminary workshop 3-4 months before the recordings that were held by a researcher who then had provided students with various links that they need to download individually to their device. As it turned out later, there was problem with getting the program function with the latest version of Java, and therefore, additional troubleshooting was required. In order to ensure that settings of the program were correct, an IT technician had also provided support for students two days before the activity was launched.

Additional, extensive planning has been conducted both by the teachers involved in the project and by the researchers, and this collaboration involved systematized schedules, workshops, oral and printed instructions weeks prior to the scheduled recordings. The tasks students had been given implied individual work and collaboration as well. The teacher and a researcher were always present during the recorded sessions. For every session, the teachers started the lessons by presenting or reviewing the tasks with the daily objectives. The recorded lessons involved different subjects, such as Swedish, Biology, Physics, and Chemistry. It is also important to note that a list of controversies had been initially established by the research group, which later, was forwarded to the teachers participating in the project along with a request that they choose from the predetermined topics. As a result, the teachers came to choose five controversies from these, namely: prenatal diagnosis, vaccine, genetic

[4] The function of these digital tools will be presented later in this chapter, along with the description of the activities done by students.

testing of adults, recycling of electronic waste, and animal testing in medicine. The current study will use video-recorded data where three controversies, vaccine, animal testing, and recycling of electronic waste are discussed. The examination of the given controversies implied the same basic tasks for students: to search for information on-line in order to create a comprehensive understanding of the arguments and actors involved. The websites that they had visited were automatically logged by a program called *Navicrawler*. Upon being installed as an adds-on of Mozilla Firefox (visible left sidewise of an open Mozilla tab, see below image), the function of Navicrawler is to collect data from web sites by saving the browsed pages along with the connected subpages that are linked. This tool is for mapping, and during the 'mapping process' students practically click on various websites displayed on Google search (see picture 2).



Picture 4. Navicrawler

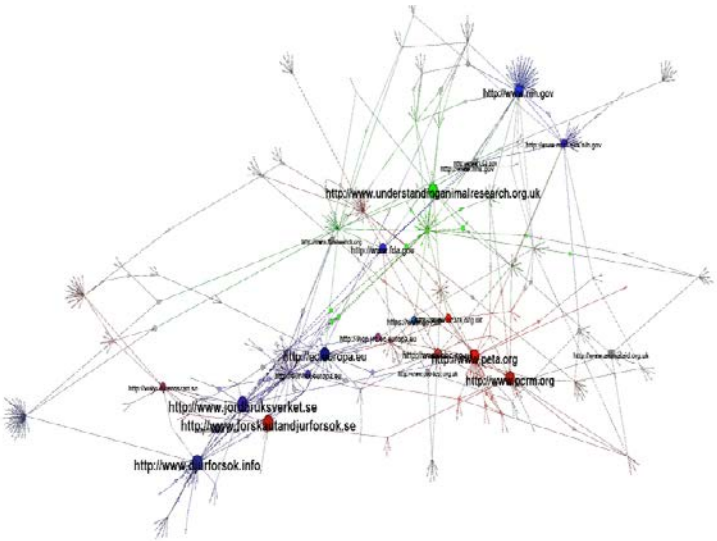
Additionally, it is possible to limit information sought this way by manually controlling which sites to save or exclude. By clicking on the 'IN Sites', students can see a list of all the sites they have visited through Google search. The value of the button is also to increase by 1

the number for each website that they visit, and can thus see how many sites are listed that way. The value of 'NEXT Sites' also increases as they get this information about the number of outbound links on the current web page. These links can therefore be displayed by clicking on the 'NEXT Sites'. If there is need to remove sites from either 'IN Sites' or 'NEXT Sites' – in case a certain page cannot be classified as relevant for the mapping of the given controversy – this can be done by holding down the Shift key and clicking the appropriate link in the list. By doing so, this website will end up in the 'OUT Sites' instead. Web sites enlisted in 'OUT sites' will automatically be classified as non-relevant for the mapping, and will also be excluded from the map even if the next or previous locations visited may be linked to this. Consequently, it is very important to carefully review the 'NEXT Sites' and to sort out irrelevant sources because considerable amount of pages is linked to such sites, for example, Facebook, YouTube, Google Ad Manager, etc.

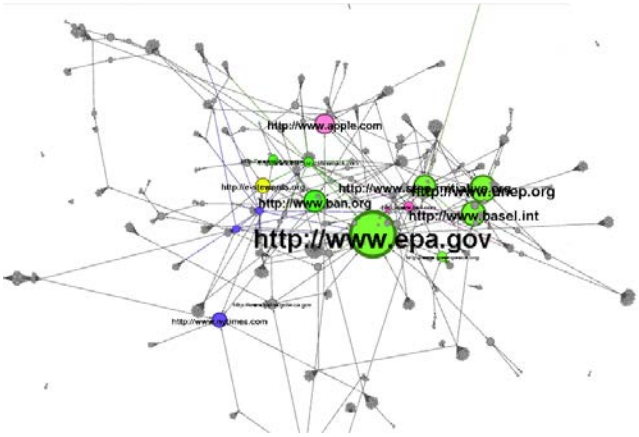
After a throughout web-search, students had to select the most relevant and trustworthy sources by deleting all other websites from the list that Navicrawler saved on the left hand-side of their Google search. Simultaneously, students were logging their reasoning and observations of selecting their sources in a separate Word-document, called log-books or memos, i.e. "PM"s ('promemoria' in Swedish). Based on explicit oral and written instructions, students had to save these websites in form of a single file on a virtual platform, called V-class, provided by the local school. After that, they had to open these documents with the help of the visualization tool called *Gephi*, and by doing so, the program automatically created their maps of the controversies.

The function of *Navicrawler*[5] is to collect data from web sites by saving the browsed pages along with the connected subpages that are linked, which becomes the base for mapping controversies. *Gephi*[6], on the other hand, is a software application, which enables visualizations or maps e.g. on how different websites relate to each other. To obtain this, the user needs to have collected information from websites, by using the tool Navicrawler first. Both tools were developed by Science Po Medialab[7]. Pictures 6-8 are some examples of complete controversy maps:

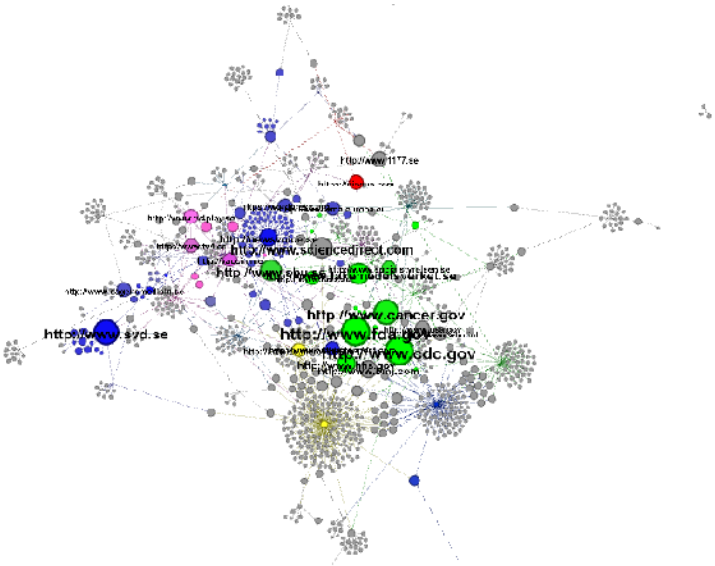
[5] http://webatlas.fr/wp/navicrawler/
[6] www.gephi.org
[7] http://www.medialab.sciences-po.fr/projets/



Picture 5: A controversy map of animal testing

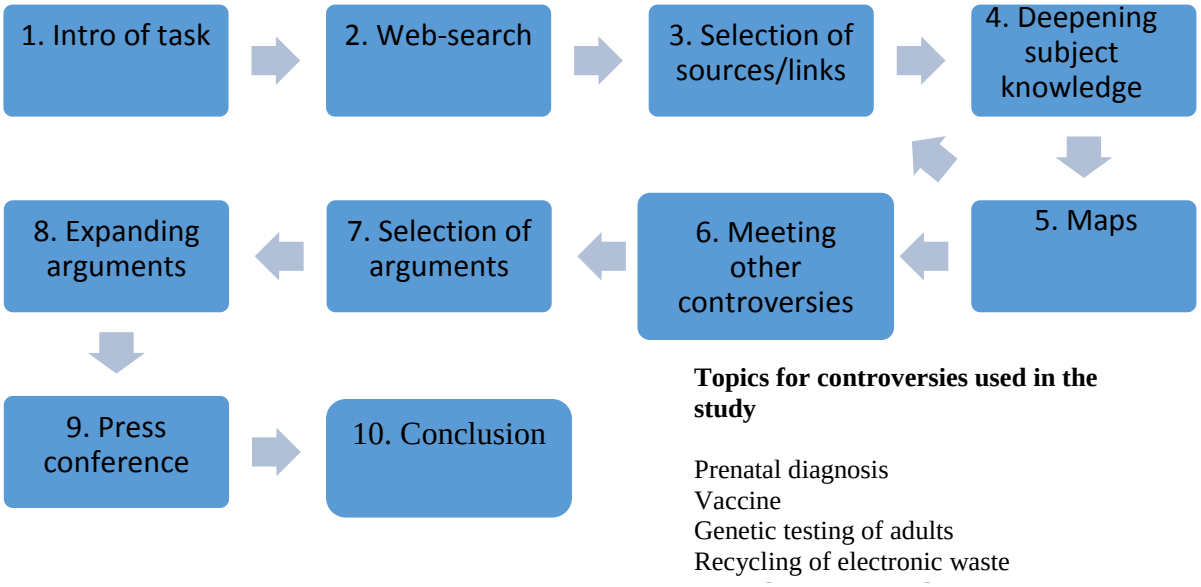


Picture 6: A controversy map of E-waste



Picture 7: A controversy map of vaccine

In order to have a clear understanding of what the various steps in students' activities imply, a description of these is also provided in the planning and the schedule of the student project. Each of the following steps represent a systematic task that can take place in the same lesson but they can also cover more than one lesson. Picture 8 synthetizes the teachers' description of the activities for classroom lessons. The information is taken from the planning and some meetings of the project supporting the teachers.



Picture 8. Planned activities for classroom lessons

Step 1, introduction to task. As a first step, tasks are explained for students in relation to their school-subjects and to the purpose of their assignment. Controversies and grouping of students are also presented. Students were initially divided into small groups of four and five, and each group represented one controversy (*e.g.* vaccine group, e-waste group, etc.). As has already been mentioned, the first session where the digital tools have been put into use, students have already had a workshop where an IT person and a researcher from the University of Gothenburg have made sure that everyone has all the applications they need and the right versions of the program needed to complete the tasks.

Step 2, web-search. During the web-search students work with their controversy, and they scrutinize the web by using Navicrawler as a tool for saving information. Handouts and crib notes are available for students on how to use of the program.

Step 3, selection of sources. Selection of sources implies an activity where students are filtering their list of links based on given criteria and by their own reasoning and source-

criticism. The matter of students' choices of relevant sources is documented in a separate Word-file along with keywords or names of companies used during the web-search.

Step 4, deepening subject knowledge. It involves the students' process of doing in-depth studying of the given controversies, which is also done on-line, either individually or together with nearby seated students. Students' direct questions about controversies or instructions from teachers or the researcher are involved. This is of preparatory importance because each student should be able to answer questions on the given topic during the press conference.

Step 5, creation of maps. The next significant step is when students create their maps of the enlisted links with the help of the program Gephi. Input from the teacher and researcher is needed in how the maps will be sorted and analyzed. Students identify the various actors of the controversy (e.g. companies, organizations involved in the controversy), and they try to reveal what arguments, standpoints are involved. Students document these details in a Word-document. They sit in their own group here (one controversy per group).

Step 6, meeting students from other controversies. During this stage, students are re-grouped in groups of four, yet each student represents a different controversy. In the new mixed-groups, students share with each other information about their maps.

Steps 7 and 8, Selection and expanding of arguments. These are important stages for understanding the controversies (for, against, representing both pros and contras, neutral, etc). By this time, students have also taken their own standpoint in the controversy (for, against, neutral), which is revealed by their explanations of the maps. The aim of the mixed group discussions is that students present for each other their own understanding of the particular controversy, and that they are able to name and talk about the various actors involved (companies, individuals, government agencies, etc). This signifies a refining and expanding of arguments of the controversy, which is also a preparation for the next step: the press conference.

Step 9, press conference. Students account for their arguments by way of a press conference role-play. Some students may take the role of journalists who may pose questions to the various actors of the particular controversy. One teacher plays the role of a moderator of the discussion. Teachers assess the work of students.

Step 10, conclusive phase. Finally, there is moment for individual accounting instances, such as problematizing the argument in form of a final seminar. Teachers assess the work of students.

On the whole, it can be said that students' activities with controversy mapping involved four major work-flows: *inquiry* (individually and in a group: identifying the area of the

respective controversy, generating a physical image of the interrelated actors: *stages 1-5*), *analysis* (both in oral and in written form: evaluating the different aspects, actors and arguments of the controversy; documenting results; *steps 5-8*), *role-play or press conference* (students represent one of actors from their controversy maps; their views need to be able to answer critical questions from so-called journalists, i.e. their classmates; teachers individually evaluate students' performance according to particular subject-requirements; *stage 9*), *final seminar* (an opportunity for students to prove their in-depth knowledge, namely what they have learned about the controversy they have explored; students discuss the role of nature of science in society and may draw conclusions about other controversies than their own; individual assessment in Physics; *stage 10*).

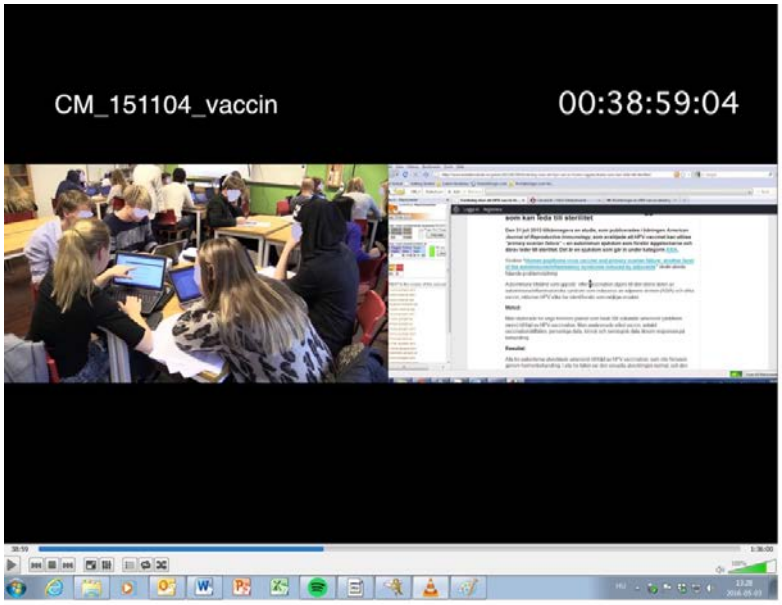
In this thesis the three excerpts chosen to illustrate different aspects of students' project work are from different steps. Excerpt 1 is from *stage 2*, excerpt 2 shows interaction from *stage 3*, and finally excerpt 3 involves *stage 6*.

Findings

The findings are presented by introducing the selected excerpts with an ethnographic description. Thereafter the excerpts are presented and analyzed.

Excerpt 1: Understanding the nature of information search on HPV vaccine.

Focus question: *how deep should students go into the web sources during information-search*?



Picture 9. Excerpt 1, more specifically turn 6-8

In excerpt 1, the students sit in a group of five around a table, and each student has a laptop in front of him/her. The first excerpt illustrates how the students in their group scrutinize various on-line sources to collect information about their controversy; vaccination. The main focus of their search is the HPV vaccine[8]. The interaction illustrated and analyzed in this excerpt is performed by the two girls of the group, Ana (with the ponytail) and Vicky. The chosen turns are part of phase 2 (picture 8), i.e. students' web-search activity. After some quick remarks (e.g. how to pronounce 'cervarix') the students carry on with silent work for less than a minute. Everyone is deeply focused on their own resources, and on the information they are looking at. The activities with the digital tools (Google, Navicrawler) of this instance involve search and exchange of information about the side-effects of the HPV vaccine. Both Ana and Vicky are surfing back and forth between different Swedish and American websites. As they are both switching between different web pages, they make recessive searches as well by often clicking on the backwards button and Ana's search is visible thanks to Screen-o-Matic. Ana opens the website http://vaccin.me/ from Google search, and then she clicks on a link which takes here further into an article on Gardasil –a type of HPV vaccine-, but within the same web platform. That article contains a link which Ana clicks, and it directly takes her to an American physician's website (http://www.mercola.com). She then clicks the backwards button, and returns to the Google search, where she clicks on another website, called www.kostdemokrati.se, which is a Swedish blogsite about nutrition, health, environment and democracy. Its information is mostly retrieved from science (scientific studies) and individual experiences (forum discussions of members registered on the website). Ana turns the monitor towards Vicky, so that she can also be part of the activity. The excerpt starts with Ana's remark about the side-effects of the HPV vaccine.

01. Ana: ((Ana turns her laptop half-way towards Vicky and reads out
loud a statement)) rrr:ight, there was that. research shows that hpv vaccine can harm the ovaries and it can lead to (sterility)]

[8] This controversy includes identifying the types of HPV vaccines (Gardasil, Cervarix), the benefits of HPV vaccine, possible side effects of HPV vaccine, pros and cons of vaccination, and other similar aspects.

02. Vicky: [but it sounds so weird (.) ((casts a quick glance atAna's monitor, andreacts in a nearly audible voice)) ◦but look for the source
03. Ana: but it was a]
04. Vicky: [but I mean if it’s not necessary]
05. Ana: [what was this source? here it says something
(0.10)
06. Ana: here (.) here it says (.) american journal of reproductive immunology (.) a study (.) right (.) here it is (.) resear (.) it’s called kost (.) the website is kostdemokrati[9] something (.)
((Ana turns her laptop more towards Vicky who leans towards it for a quick moment. Ana fingerpoints at an embedded hyperlink with a title in English.))
07. Vicky: but what’s the name of that source?
08. Ana: oh, let’s see. it’s called (.) there ((Ana finger points at the name of the website http://www.ncbi.nlm.nih.gov/pubmed/23902317 which is a scientific database. Vicky looks at Ana's monitor))
09. Vicky: but I meant the one with kostdemokrati (.) what was that study?
10. Ana: ah, research shows that] ((although the page that opens on the screen is the American scientific database, when shereads out loud, Ana is pointing at another tab, namely to a Swedish webpage, kostdemokrati.se))
11. Vicky: [go to that one (.) there ((Vicky points with her finger to Ana's monitor, more precisely, on the tab for kostdemokrati.se. Ana switches to that, and then Vicky points into the text.))
12. Ana: uh-huh (.) american journal of reproductive

[9] food democracy in English

immunology ((Ana reads this from kostdemokrati.se, which is a Swedish website, and she struggles somewhat with pronouncing the last word))

13. Vicky: ((Vicky looks carefully at Ana's monitor as she types this name into her own google search, she is spelling the words aside))
14. Carl: trick or try! ((seems to think out loud or to simply read something out loud to himself))
15. Ana: ((Ana switches to the tab for the American database, which contains an abstract of a study: problem method-results conclusion. she sighs deeply and holds unto her head)) do we have to actually understand all this? it's full of(.) problematization and stuff (.) god, I don't get any of this (.)

Analysis of excerpt 1

In turn one, Ana has found information about the vaccine expressing that it could lead to sterility. She turns to Vicky who sits next to her, and asks for confirmation on her interpretation of the reading. Vicky is however not convinced uttering [but it sounds so weird (.) (turn 2) and asks about the source. Ana's uptake of this is that she tries to identify the actors behind the argument she reads, and she succeeds in doing that with the help of Vicky who points with her finger where to click when Ana gets lost in her text. When Ana starts looking for that, she is pointing with her finger at a study, which the article refers to (American Journal of Reproductive Immunology). In turn 3 Ana continues by trying to comment on their information search, but is cut off by Vicky's comment [but I mean if it's not necessary] in turn 4. This is topic related to an earlier discussion they have had on the necessity to take the vaccine or not. In turn 5 and 6 they return to the discussion about finding the original source where they have retrieved the information. In turn 6 Ana has found a name of a scientific journal and a name of a Swedish website and is unsure of how to interpret this information, turning her laptop to Vicky. In turn 7 Vicky repeats her question about the name of the source. Then Ana points to the text on the webpage kostdemokrati[10], which argues that the HPV vaccine could lead to sterility. When they have settled this

[10] http://www.kostdemokrati.se/guests/2015/07/18/forskning-visar-att-hpv-vaccin-forstor-aggstockarna-som-kan-leda-till-sterilitet/.

webpage as the source, Vicky continues by questioning it `but I meant the one with kostdemokrati (.) what was that study?` (turn 9). Ana continues to read on the webpage and reads out loud `research shows that` (turn 10). Vicky continues by pointing at the screen to a link that is mentioned in the article, which leads to another scientific journal[11], which turns out to be a scientific study in English from an American science database, i.e. the National Center for Biotechnology Information. In other words, an embedded link on the first webpage takes the students further into a new layer of information. As they glance on the text of the screen Ana utters reluctantly `do we have to actually understand all this? (…) I don't get any of this` (turn 15). She sighs deeply and her facial expression reveals that she is confused as she looks at the American scientific database, which contains a scientific abstract of a study: problem-method-results-conclusion.

One interesting finding of this instance is that the web page students open from Google search is only one layer of the information that refers to a scientific study, i.e. another layer, which can be opened by a direct link from the earlier layer. So, the first webpage is a reproduction of the study that students talk about. Moreover, since it is in Swedish (www.kostdemokrati.se), it is basically a translated version, which facilitates the consumption of information and it addresses a more general audience. Furthermore, when students take a step back in their search for the original source, they end up in the middle of science, a database, which stands behind the ideas and behind the work of the study itself. The first webpage is only one voice on the topic, the first layer, which can be linked to the next layer and to the one after that is a scientific source. This actor of the controversy (kostdemokrati.se) is one that reports on a research study, which again is connected to other studies. Consequently, this can actually be seen as a *never-ending regression of scientific texts*, i.e. that there are many references and layers for information on the web, which the students are to explore, yet it challenges their understanding more than they expect. Taken that there is an extensive structure of *multiple layers of information* that can be winded further, this may cause more and more difficulty in students' understanding of it. Evidently, when too much information is included in the web structure, the mediating process becomes too complex and the students do not understand the information.

However, Vicky tries to identify the actor in turn 9 by saying `but I meant the one with kostdemokrati (.) what was that study?` She refers to a source

[11] http://www.ncbi.nlm.nih.gov/pubmed/23902317

(kostdemokrati.se) that led them to the scientific database, i.e. she is switching between different layers of information. Step-by-step Ana and Vicky drift away from the initial webpage. Nonetheless, this can also be seen as part of their tasks to scrutinize the web for information, since the means by which they dig deeper and deeper are related to the aims and function of the digital tool, i.e. Navicrawler. In other words, the deeper digging is enabled by the inherited affordances of the tool. Their activity of working with controversy mapping implies that students should surf the web and try to find information. However, in this instance, Ana and Vicky do not simply scrape the web and collect pages through Navicrawler, they make an attempt to look for specific aspects of the controversy in order to understand them, and above all, they want to see *what* the source is and *who* the actor of the controversy actually is. In other words, students do not only look for facts, but rather for actors behind information. This can also be explained by the nature of the assignment, namely that the instructions of the task suggest that students look for various types of sources in order to find the most important actors of the controversies. As it is revealed through their interaction, there are several layers of actors, which is a peculiar feature of the web structure and of the Internet itself. One of the aims of using Navicrawler is that students surf on the Internet and they collect information by simply clicking on websites, but on the other hand, they become eager to understand what they encounter (instead of just clicking and skimming). Analytically, the activity in the excerpt is understood as if the students are partly driven by curiosity, which is visible in their non-verbal interaction, such as facial expressions or the way they finger-point on the screen (turn 06 and 08). Additionally, students are also driven by the fact that they are aware of the school-task, namely that they will need to give evidence of having understood the information for the oral presentations of the controversies. The students know what they are expected to do in accordance with the assignment. Nonetheless, they expand the tasks by engaging into more complex information-search. As a result, they begin to dig deeper than expected because they want to make more comprehensive meaning of what they read. For this reason, they proceed from a task, which is designed in a certain way into another kind of meaning-making activity. In other words, the students expand their activity from ‘simple surfing’ into deep-browsing from one webpage to another. This shows that they have a different interpretation of surfing from what their assignment says, and this is also visible in their verbal interactions as in turn 02 when Vicky says `but look for the source`.

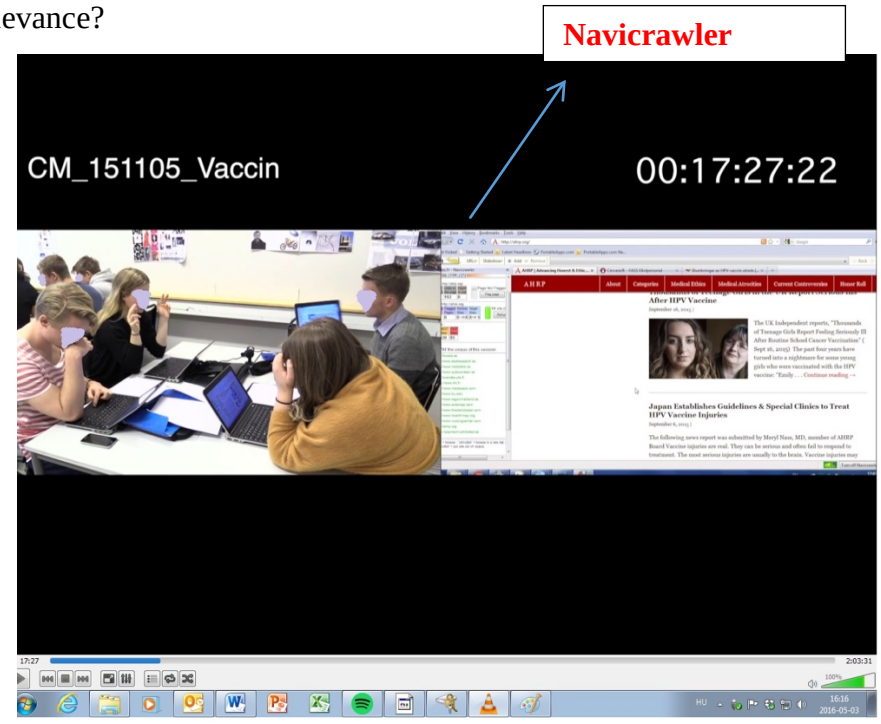
Another interesting feature of this discussion is that neither Ana nor Vicky take a standpoint about the sources, but they explore them instead by diving into the web structure. They go from one link to another until they are restrained by not understanding any longer

what the source is, and it becomes incomprehensive for them. One reason to this is that they run into a source that is suddenly in advanced scientific English, while the other reason is that they struggle with trying to understand complexity of various layers of texts and sources at the same time. When they think they have come across something relevant to their task and their controversy they try to go deeper in order to reveal the source is, but they encounter layers of layers of layers. They read the first layer, then the second, and as they go on, it becomes more and more difficult for them to understand. This can be seen as an example of an instance in the learning activity where information-search becomes a *scientific trajectory*, i.e. moving across different websites, where students are driven by their curiosity to know more. In other words, they want to reveal what the source actually is.

This excerpt illustrates how the girls navigate through the layers of sources on the Internet. The more thoroughly Ana seeks into her sources the more confused she appears; she wonders if they have to understand all that complicated information. Their interaction shows interesting aspects of the complexity of firstly finding the original source, and secondly, understanding, examining and assessing the source in learning activities that include web-based information sources.

Excerpt 2: Students discuss source-credibility for information on HPV vaccine.

Focus question: what are the criteria and the challenges for students to evaluate web-sources and their relevance?



Picture 10. Excerpt 2, more specifically turn 8

In excerpt 2, students sit in a group of four around a table, and same as in excerpt 1, students work individually on their own laptops in front of them. The activity in Excerpt 2 is mostly an example of students working with Navicrawler and Google search from stage 3, i.e. selection of sources (picture 8). Their task is to search for information on the same controversy as in excerpt 1, i.e. the HPV vaccine, by surfing as many websites as possible. With exception of one student, the same individuals from excerpt 1 are present in excerpt 2. Nonetheless, besides Ana and Vicky, Ted is also involved in the interaction here. Everyone is busy with doing web-search in Google, and while some are puzzled with specific features of Navicrawler, which are visible on the left margin of the open Google window (Picture 10), others wonder if they can trust data from particular pages. In other words, the students start to evaluate the web-sources and try to determine which can be considered as relevant websites. The excerpt begins with Ted's question about threads, i.e. single-threaded conversations on discussion forums.

01. Ted: these threads, like flashback for example ()is it this that we're talkin about?
02. Vicky: but those are not facts or so-]
03. Ana: [facts?]
04. Ted: [but it's people's opinion
05. Vicky: a:::a] ((with an intonation that reveals skepticism))
06. Ana: [but-]
07. Ted: [there are many, many opinions
08. Ana: but that is very (.) you can say impartial in that case((Ana makes quotation marks in the air with her fingers when she utters the word impartial))
09. Ana: so it's about-
10. Ted: ((turns his laptop so that Ana can see his monitor))
11. Ana: what's that?
12. Ted: facts mean that you're impartial to ◦somethin ()
13. Ana: ((leans forward to read into Ted's page)) oh, so you mean like flashback?
14: Vicky: you can find different blog opinions like this,

there's alot of debates () I mean a lot of unserious () so, it's like () if you say something, say it so that it's not like biased, I think ()

15. Ana: but, I mean views like this (.) you can have in this case

16. Vicky: here (.) politician (.) I've found like a debate article (.) aftonbladet (.) but- ((she reads out loud from the article)) Jessica Ericsson, politician in Stockholm county council wants that men who have sex with other men get the HPV vaccine (.) ö::: blablabla (.) sounds logical.
((the pronunciation of the word aftonbladet[12] is combined with an ironic tone and frowning, followed by an abrupt conjunction, which shows that Vicky has the idea that debates and newspapers can be biased))

(0.16)

Analysis of excerpt 2

Ted initiates a group discussion by raising a question about a more general category of types of webpages when he says in turn 01 `these threads, like flashback for example`. However, the real question is if this type of website is relevant for the task with controversy mapping, as uttered in turn 01: `is it this that we're talkin about?` Vicky's reaction in turn 02 implies that one of her criteria for a trustworthy source is that it is based on facts. In the meantime, Ana's question: `facts?` in turn 3 shows that she is having a hard time to understand what Ted and Vicky are referring to in turn 1 and 2. Ana's confusion is also visible as she asks for clarification or confirmation on some occasions later in turn 11 and 13. Additionally, Ted's verbal interactions prove that web-pages containing personal opinions are just as important for him as fact-based sources are for Vicky. This can be seen through his emphasis of the word `opinion` in turn 4 or by the repetition of `many` in turn 7: `there are many, many opinions`. Ana rephrases this in turn 8 by categorizing this type of web-source – on-line forum – as `impartial` on the controversy. However, even on this matter, she seems to hesitate because she makes quotation marks in the

[12] Daily newspaper in Sweden

air when she utters the word, `impartial,` which gives evidence of using the adjective in a figurative sense. Ana's confusion about knowing exactly what the discussion is about comes forward in turn 9 where she again tries to rephrase her understanding of the discussion by saying `so, it's about-`. Moreover, this perplexity re-occurs in turn 10, 11, 13, when she raises the question `what's that?` (turn 11) or when Ted turns his laptop towards Ana (turn 10), as a way to show her and help her understand what they are talking about, upon which she asks for his confirmation `oh, so you mean like flashback?` (turn 13). The discussion continues with Vicky's reasoning about what sources they should or should not include in their task (turn 14). In her reply to this, Ana tries to deliver a compromise as she says in turn 15 that such opinions –which Vicky calls for `unserious` in turn 14- can be accepted websites such as Flashback, which may contain rather extreme views as well. After this segment, Vicky reads out loud a report from the media in turn 16. This is followed by silent pause, which gives space for students to process information, therefore such non-verbal elements (pause, silent work) are also important in project work that implies group interaction.

In excerpt 2 students start to discuss the means and criteria by which they intend to *evaluate the sources* that they will use to describe their controversy. It is to be noted that this is part of their tasks as well, yet the verbal and non-verbal features of their interactions show that it becomes rather challenging to evaluate web-sources. In other words, excerpt 2 is about instances of how students relate to the web-sources that they use, what type of sources are part of their discussion and how they relate them to their understanding of the information. Apart from the complexity and the variety of the types of web pages that they encounter, they also need to make compromises within their group. This is mostly due to the fact that they have different view on what constitute relevant sources for the activity at hand. Their concerns of what to include into the traditional ways of handling sources and *source criticism* are also part of school assignments. Nonetheless, this can be seen as a tension of bringing in controversies into the science classroom.

Additionally, we can see how the students rely on each other for explanation when they try to evaluate what counts as a trustworthy source for their learning task. Thus, *source-credibility* of information is important for the students as they share their uncertainties about the topic. This is shown in turn 02 by Vicky's reactions to Ted's question on whether information from Flashback blogs can be considered as impartial opinions regarding HPV vaccine. As students seem to have different opinions about forums and blogs, they are clearly

hesitant to bring in Flashback as an actor of their controversy. Vicky argues that Flashback `but those are not facts or so-]` (turn 2). As a next step in students' discussion, it can also be concluded that a re-confirmation from another person in the group seems to be of great importance when students feel unsure about their understanding of the information. Examples of this are: Ana's utterance in turn 13 `oh, so you mean like flashback?`, or her repeating question in turn 03: `facts?`

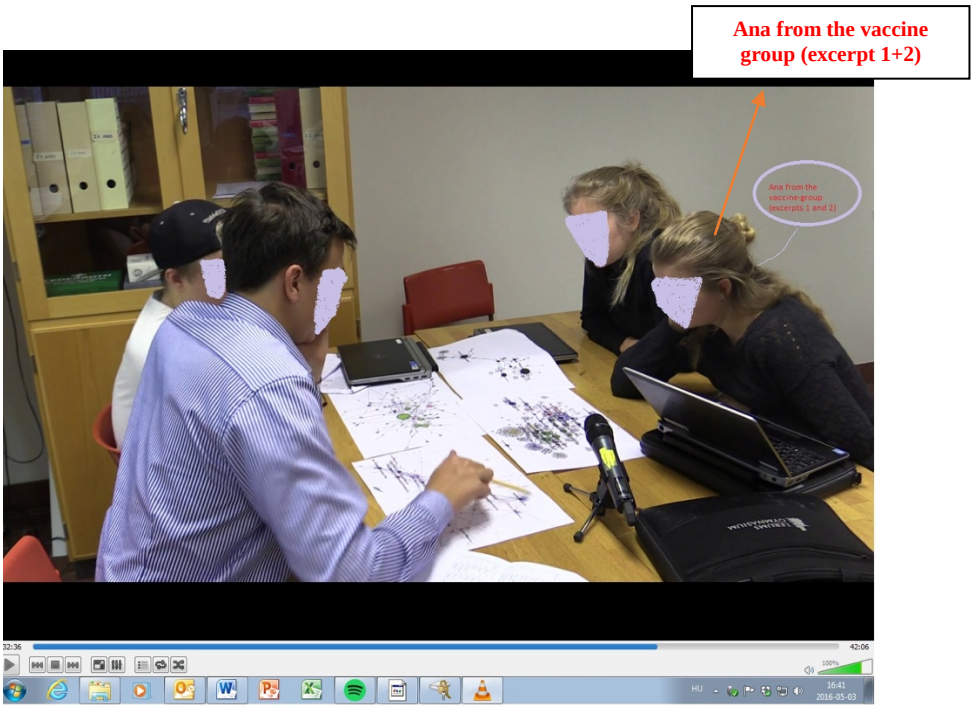
Another valuable finding in excerpt 2 is that it becomes visible how the students learn through their interaction (Vygotsky,1978). More specifically, students interact with the information by scrutinizing the web, which can be seen when they think aloud and reason with themselves, for example in turn 14, 16 or 18. But mostly, interaction is done with the others in the group, for example when Ana asks for Ted's confirmation in turn 13 `so you mean like flashback?` or when Ana expresses somewhat disagreement with Vicky in turn 15 when she argues that personal opinions could well be considered in mapping their controversy. These levels of interaction point to challenges implied when students try to evaluate web-sources in the aspect of credibility. Furthermore, these segments of interaction also show that group discussion serves as effective scaffolding in such situated learning activities (Säljö, 2000).

Last but not least, the discussion of students about different types of sources, such as blogs, Flashback, evening papers also shows that students are not used to talk about these in a school context. This tension relates to their dilemma about whether non fact-based sources, such as blogs and forums with personal views ought to be considered as trustworthy or not. This is, for example, visible in Vicky's argument in turn 2, according to which they should be looking for facts. In another instance, in turn 14, she takes standpoint on how views from blogs are biased and therefore, cannot be trusted: `you can find different blog opinions like this, there's a lot of debates () I mean a lot of unserious () so, it's like () if you say something, say it so that it's not like biased, I think ().` On the other hand, Ana argues that such views display different opinions of a controversy, which should be taken into consideration (turn 8 and 15). Ted continues this thought in turn 12 by his definition of what facts actually are: `facts mean that you're impartial to ◦somethin ().` Vicky's skepticism about sources is first shown in turn 14 where she takes a clear stand against blog discussions, and later as well, in turn 16, where her intonation and verbal hesitation show that she has a difficulty to trust political voices coming from newspapers.

These instances show interesting examples of how students themselves have different opinions and different interpretations of what facts actually mean for information-search because this is also what controversies are, as such. Ana's standpoint is clearly that personal views from forum sites are important actors of the controversy, while Ted claims that facts are neutral views, and are therefore also important. Vicky, on the other hand would rather rely on more scientific studies to get an unbiased presentation of the controversy.

Students' evaluation of the sources and making sense of the information retrieved from these sources drift to a new level of their discussion where they present the printed maps to each other in small groups of students from different controversies.

Excerpt 3: Making meaning of specific search strategies used to create the maps.
Focus question: How do students reason about the production of the maps based on the different search strategies?

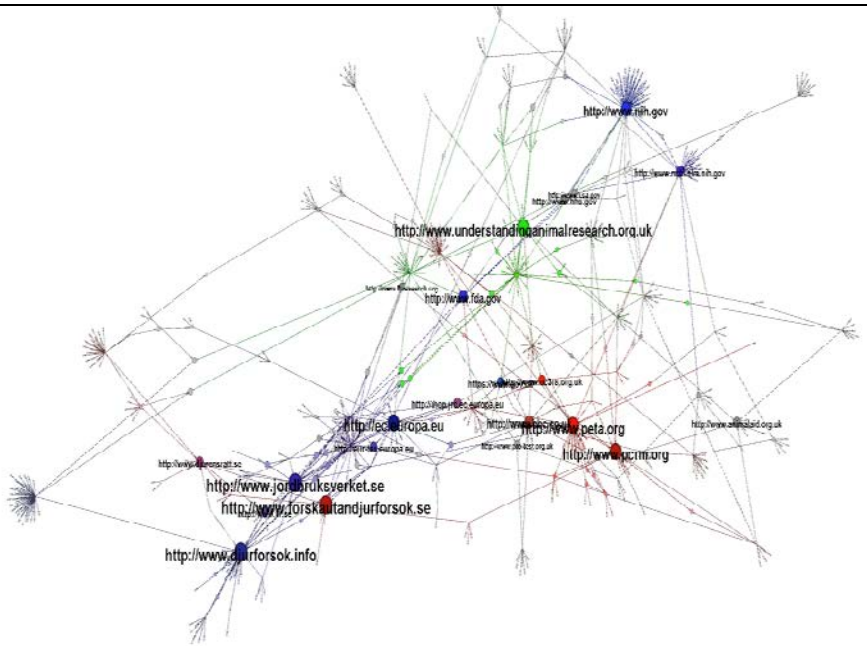


Picture 11. Excerpt 3, more specifically turn 4

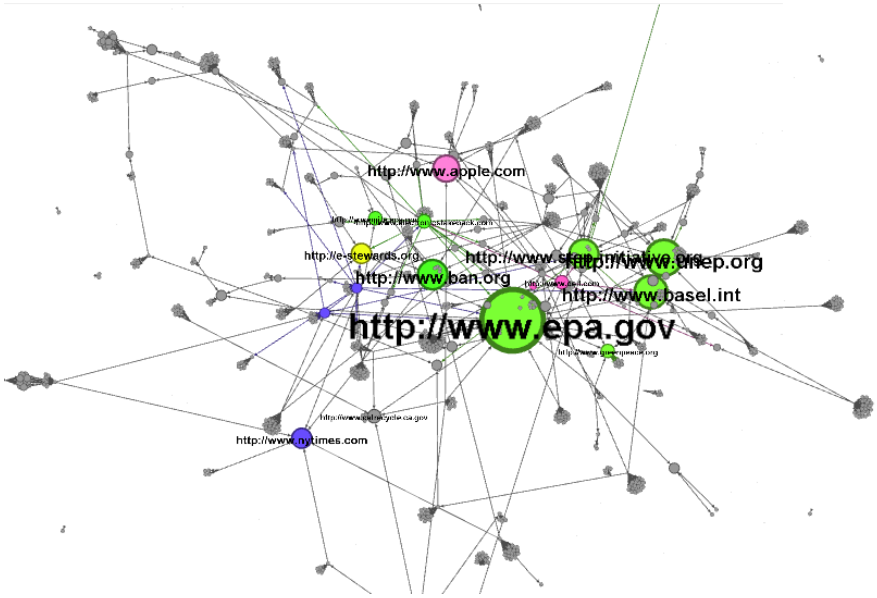
A significant feature that distinguishes excerpt 3 from 1 and 2 is that students no longer work with their laptops here, but their laptops are replaced by the printed maps of the various controversies. Excerpt 3 belongs stage 6 (picture 8), i.e. meeting other controversies, and the

turns presented are instances where students discuss their *strategies of information search* by referring to how their controversies are displayed on the maps.

As illustrated with picture 11, only one student has a laptop in front of her, yet the laptop is attributed a completely passive role in the group's interaction here. Additionally, it is important to emphasize that excerpt 3 is part of a session where the main activity involves intensive group discussion with much verbal and non-verbal interaction, and where students sit with their printed controversy maps and they try to compare them in order to find parallels and differences between how the maps have been created. This group consists of four students from different controversies, namely (picture 11): animal testing in medicine (Tom, boy with the pen), recycling of electronic waste (Josh, boy with a cap), vaccine (Ana, facing Tom, and she was present in excerpt 1 and 2), and prenatal diagnosis (Emma, sitting vis-à-vis Josh). The complete maps that students discuss in this excerpt are also illustrated by picture 5, 6, and 7 on earlier pages. Nonetheless, as most of the interaction analyzed in this excerpt is centered around two controversies: e-waste (Josh) and animal testing (Tom), a picture of each is inserted below in order to facilitate the flow of analysis.



Picture 12. Tom's map (animal testing)



Picture 13. Josh's map (e-waste)

As presented by the below turns, students talk about the country of origin of the actors for the particular controversies (American, European, Swedish) in relation to ways of searching on-line. Accordingly, their earlier methods of web-search, such as the language used for the keywords, have also much relevance to the results displayed on the maps.

---

01. Tom: our group, our group has done a geographical distribution(.) here, here is like]
02. Josh: [here, here is about the languages]
03. Tom: ah::a yes, indeed, I think so too ((points at his own map))
04. Tom: ((makes a circle in the air with his pen, right above his map, first to the bottom, then to the top part and the right side of it)) here, here we have a bunch of Swedish and here we have a lot from the rest of the world, most from the US and from England
05. Josh: all right (.) did you guys use different keywords for the domains you ◦went in? you did search both in English and Swedish with the same keywords, right?
06. Emma: ((points at Tom's and Josh's maps)) that's probably the difference between ours and]

07. Tom: [exactly, cause you, cause yours is more organizationally divided]
08. Ana: [but:umm]
09. Josh: [we had, we had, we had English keywords (.) only]
10. Tom: [only?
11. Josh: yes, didn't search in Swedish
12. Tom: ok
13. Josh: only]
14. Ana: [°ok
15. Josh: we took, or we noticed that information, I mean the amount of information that was available (.) it was very different if we searched electronic waste (.) ah, or elektroniskt avfall[13]
16. Tom: but it would still (.) I would think that (.) I'm guessing (.) that if you had searched a bit more on Swedish stuff then you'd probably have a geographical]
17. Josh: [uh-huh, it's surely visible]
18. Tom: [in any case, you can feel that Swedish organizations are a bit more aware about (.) recycling or that] ((he is cut off by Josh))
19. Josh: [yep, it could be, it could be if you (.) if you searched in English (.) and in Swedish (.) then perhaps the Swedish source afterwards would be connected to the organizations]
20. Tom: [I agree]
21. Josh: [and then the American would perhaps come a bit on the side of it (.) it's like (.) it's like (.) here you have a lot of American websites ((he finger points to his map))

[13] electronic waste in Swedish

Analysis of excerpt 3

The students are busy with trying to understand each other's maps and the positions of the various actors displayed by the nodes of the map. A significant aspect of the instances in excerpt 3 is that the completed and printed versions of the maps are the results of students' search strategies used with the help of the digital tools (Navicrawler, Gephi).

Tom introduces his map on animal testing by underlining the structural layout of his map, which is practically a *geographical display of the controversy*: our group, our group has done a geographical distribution (turn 1). Josh's quick reply to this in turn 2 indicates his understanding of *the role of language* in the layout of the maps. Tom carries on this thread in turn 3 and 4 by making circles in the air with a pen, right above his map. He points to various parts of his map (picture 12), i.e. different sections centered around larger nods, more specifically, the bottom part of his map (dark blue nodes) are Swedish web-sources and actors, whereas the top part and right side of his map (light blue and red nodes) stand for sources in English, which represent American and other international actors. In other words, they unpack and discuss how they came about the maps through their *different search strategies*. Tom, for instance, talks about aspects of language use from his search, which reflects a geographical location of his sources: here, here we have a bunch of Swedish and here we have a lot from the rest of the world, most from the US and from England (turn 4). His understanding of the layout of his map is presented with the help of a tool (pen), non-verbal elements of communication (finger-pointing, making circles in the air) and through verbal interaction alike. The use of cultural tools, i.e. language, is further on emphasized by Josh in turn 5, where he raises the question of using different languages, i.e. English and Swedish for various keywords in their on-line search: did you guys use different keywords for the domains you °went in? you did search both in English and Swedish with the same keywords, right? Emma's reaction to this in turn 6 shows the clear difference between how the maps are displayed in the group: that's probably the difference between ours and]. She pinpoints an interesting contrast between the maps, namely that they have been using English and Swedish keywords when searching for web-sources. Although Emma refers to the maps, the distinction relates to how students have sought information. Namely, this is an example of how the language of the keywords that students used during information search is considerably significant for the results they get when the web-sources are displayed on the printed maps. After this, Tom relates his

agreement in turn 7 to the visual and structural layout of the maps: [exactly, cause you, cause yours is more organizationally divided]. Turn 8, 9, 10, 11, 12, 13, and 14 demonstrate a clarification of each student's language use in the creation of the maps. Accordingly, some resorted to English keywords only, some to Swedish, while others used both. For example, Josh used English keywords, Tom resorted to Swedish words only, and Ana used both Swedish and English words. The importance of this is that one type of keyword may be relevant for a particular controversy, but irrelevant for another (e.g. there may be essential differences among countries in prenatal diagnosis or the types of vaccines in public health care or the attitude to animal testing or the means for recycling electronic waste). An explicit conclusion of the importance of using different languages in their on-line information search comes in turn 15 when Josh utters: we noticed that information, I mean the amount of information that was available (.) it was very different if we searched electronic waste (.) ah, or elektroniskt avfall. Accordingly, there is clearly a difference in the amount of information and in its content whether they read on the actors of a controversy in Swedish or in English. On the other hand, Tom draws attention to a different perspective when he formulates in turn 16 that there may be distinction among the actors of a controversy even if they sought within a Swedish context only: if you had searched a bit more on Swedish stuff then you'd probably have a geographical]. In the view of this, it becomes evident that when students talk about the various actors behind their sources, in fact, they discuss specific aspects of the controversy. A clear example of this comes in turn 18, when Tom asserts that Swedish companies are more aware of recycling, and by that, perhaps eco-friendlier and more considerate in their actions. Furthermore, he makes another interesting point in turn 16 when he tells Josh that his map would probably have shown a more geographical division of the actors if he had included Swedish keywords in his search along with the English ones: but it would still (.) I would think that (.) I'm guessing (.) that if you had searched a bit more on Swedish stuff then you'd probably have a geographical]. Josh further problematizes the structure of the map in turn 19 and 21, which shows how the controversies may manifest differently in different countries (e.g. in Sweden or in the USA): if you searched in English (.) and in Swedish (.) then perhaps the Swedish source afterwards would be connected to the organizations] (turn 19) and [and then the

American would perhaps come a bit on the side of it (.) it's like (.) it's like (.) here you have a lot of American websites (turn 21). In other words, students discuss the results from using English or Swedish and how those are accordingly located on their maps. Moreover, they also consider options - that is alternative strategies and how they would have turned out and been placed then.

Excerpt 3 illustrates how students reason about the creation of the maps. They evaluate and make meaning of different search strategies in their web-surfing because they see the importance of this for the results they have obtained, and that are visualized by the maps. Examples of this are Tom's map of animal testing (picture 12) or Josh's on recycling of electronic waste (picture 13). Consequently, the digital tools have enabled the illustration of complex controversies in a way that has become more visible and more reachable for laymen. Overall, students realize how important their input is in using the tools because the methods, keywords they apply in the web-search affect the outcome of the maps. Practically, they are made aware of their own roles in re-presenting the controversies, and this is a very interesting finding of the current study.

Discussion

The current study describes web-searching activities of students at an upper secondary school in Sweden. The focus of the study is to explore students' evaluation of on-line information and how the information is represented with the help of a new digital method: controversy mapping. This is accomplished by scrutinizing students' interaction enabled by a detailed and close analysis (Jordan & Henderson, 1995). As illustrated by the transcribed and analyzed excerpts, students commute between different levels of dealing with the web-based information as they discuss the web-sources during the different phases (picture 8) in the controversy mapping activities. Based on the findings of the current study, the various phases for students' work with web-based information sources through controversy mapping (searching strategies, selecting, evaluating) are crucial because they interplay with what becomes possible for the students to learn about their controversies.

Excerpt 1 involves instances where students try to identify what is to be considered as a source by digging into these since they have no clear understanding of what counts as an adequate source at the beginning of their search. This mystery is disclosed through their web-surfing. The students are eager to reveal *what the original source of their information is, and*

moreover, who the actor of the controversy is. Their ways of trying to distinguish between what counts as scientific and non-scientific also becomes a *scientific trajectory* that helps them to explore the controversies. Lemke (2006) refers to this as "trajectory across links", and argues that it is a learning process in which students make meaning of information. Moreover, based on the findings of this study, students try to categorize information as 'scientific' or 'non-scientific', which becomes a condition to narrow the immense amount of information that they face. While they are doing this they run into scientific databases where the scientific source becomes too complex for them to apprehend. They find different traces of information, and this suddenly becomes excessively broad, so they reach a point where they do not understand the information any longer. As a matter of fact, their initial assignment at this stage is to simply surf. They are not required to do in-depth reading of on-line articles, yet they do that. One possible reason for this is that students are driven by curiosity, but also by the fact that they know from the objectives of the assignment that as part of their tasks, they are expected to report on the selected sources later on. They may go deep into the source, but if the ones they end up in are too complicated, they cannot report something that they do not understand. In this case – as shown in the analysis – they have to make judgment on how deep they go, and so, they need to stop in a layer where they still understand the source. Nevertheless, this is complicated, and it indicates something about validating information. Limberg (et al, 2008) also underlines the challenges of information search, as it requires activation of far more complex skills (cognitive, emotional) than what their aptitude for using the digital tools would imply. In the first excerpt the students lack to distinguish between retrieving information and doing an exploratory browsing, yet this would be important for their searching strategies (cf., Marchionini, 2006). When they come to the ground source they do not understand it and they have to rely on somebody else's review or summary of that source, and that is very interesting. In other words, students are constrained to rely on secondary sources, i.e. other resources that summarize primary and scientific studies. From another aspect, students in excerpt 1 try to determine whether the sources are relevant for their controversy by engaging in deep-reading. This contrasts the findings from Julien & Barker (2009) where Canadian students in grade 11 and 12 did quite the opposite; they simply skimmed information for relevant key words in order to assess relevancy of web-sources.

Excerpt 2 is the second level in students' work with web-sources through controversy mapping. They surf and navigate through the webpages, and they realize that there are different types of websites, so they start an evaluation of the sources as they discuss relevance and credibility for describing a controversy. The main focus in this excerpt is on source-

relevance and *source-credibility*, which as a matter of fact recurs in all three excerpts to some extent. One interesting example of this in excerpt 2 is when students discuss whether they should use threads and blogs with extreme views like Flashback. Students encounter such matters when they evaluate and criticize sources. *Source-criticism*, is therefore an interesting aspect of this excerpt, when students try to validate their sources. All the more, since source-criticism is an important part of information literacy (e.g., Alexandersson et al, 2007). He distinguishes between two types of source evaluation: internal –the relevance of information for the assignment (when students in excerpt 2 try to make a compromise in their discussion about what types of sources are relevant for their assignment), and external –focus on validity of the source (for example, when students validate Flashback and talk about whether it counts as a trustworthy source). To pursue critical evaluation of the sources becomes even more difficult for students in excerpt 2 because of the multiple layers of sources they encounter during their web-search (compared to, for example, as if they read a book where the background of the source was much clearer). On the other hand, the question addressed in excerpt 1, namely "*what is a source?"* reoccurs in the second excerpt as well, however, with the difference that students take a specific example of a type of website in excerpt 2. More specifically, they raise the question: can threads and forum discussions, i.e. blogs be considered trustworthy sources, and if not, what type of sources can they rely on? This is a dilemma on which students in excerpt 2 need to take a standpoint, and they compare various sources (blogs, newspaper articles, and scientific studies) in order to assess which ones can be relevant for their task. They start their discussion in excerpt 2 by validating Flashback, to see if that is a credible source, and if it can be used to map their controversy. This also shows how students try to situate knowledge of information in exploring source-credibility, and it unfolds through their interaction as they discuss, for example, whether they should include sources, of which they know that are not facts, but personal opinions of individuals. This finding is in accordance with the findings by Gärdén and colleagues (2014) which have showed how students in Swedish schools tend to associate facts with neutrality and to view them as evidences. The findings from Lilja's (2012) study of Swedish upper secondary students who were searching for fact-based information, also showed how the students used facts to clarify concepts and to speak about sources before the retrieved data had been rephrased into new text. In excerpt 2 students refer to fact-based information as an index for neutrality when they regard certain websites only as opinions. The interactions illustrated in excerpt 1 and 2 show how students have actually negotiated and fought their way to reach the next phase of their

interaction with web-sources, which comes with excerpt 3 where they get to make meaning of their results based on the applied search strategies.

In excerpt 3 students discuss the representation of their information search, which is illustrated by the maps of different controversies. Hence, this excerpt provides examples of how students reason about the production of the maps, which are the result of students' web-search enabled by the digital tools (Navicrawler, Gephi). By means of using these maps, the students are able to have this discussion, and to see how some of the controversies are displayed in different countries; this reveals a *geographical distribution* of socio-scientific issues. The significance of this is that both the process of creating the maps and their print version contribute to their meaning-making and to their understanding of web-based information search. This could be compared to what Limberg (1999) calls as "fact-finding" i.e. to compare sources and to formulate a critical understanding of them in relation to the controversies. In this study the maps support students in this comparison by the visualized positions of the actors involved. In other words, excerpt 3 is a meta-discussion about web-based sources and the actors of a controversy, where students evolve their views and trigger each other's understanding of the search strategies they have used.

Furthermore, the instances in excerpt 3 illustrate possibilities for learning about socio-scientific issues through the results of information search, and enabled by the digital tools. The way students use the tools for mapping is significant because it reveals what is possible for students to develop knowledge about. The tools provide possibilities for finding and evaluating web-based information sources, and they also make the controversy more understandable for laymen. Through the use of the tools in the on-line information search students become themselves agents of creating the maps and of re-presenting the controversies. Since they feed information into the tools it is the co-operation between the students and the digital tools that enables the maps. Consequently, the tools for controversy mapping *mediate* the possibility to obtain the maps, and students come to understand the significance of their own input in working with such tools. This is a crucial aspect that is revealed in excerpt 3.

Considering the overall analysis of the three excerpts, the current study has concluded some findings about the appropriation of new digital tools in the field of information search in a school context. The most important ones will be summarized below.

One important aspect of the findings is that the use of controversy mapping gets situated in students' discussion about information sources, and this relates to the sociocultural theoretical approach taken for this study. Consequently, by regarding *learning as being situated in the*

activities of students, three ways of situated learning are illustrated in the current study: a) through students' group interaction (in excerpt 1 as they discuss what is a source – their learning is situated in finding the ground source), b) as they express critique through their different views on what counts as a trustworthy source (in excerpt 2), c) in their reasoning about the applied search strategies by which their maps have been created (in excerpt 3).

From a more specific theoretical perspective, people's social interaction occurs through the use of cultural and physical tools, according to sociocultural traditions (Vygotsky, 1978). Säljö (2000) argues that the cultural tools are often integrated into the physical ones. For example, as the current study has shown, Gephi and Navicrawler are tools for searching information on-line that not only relate to the students' web-surfing activities, but they also interplay with their understanding of what information seeking is. This finding is in line with Sundin & Francke's study (2009), which has also shown that information practices, such as information search, evaluating sources, or source-credibility are often formed in relation to available digital tools, such as databases and computers. Overall, earlier research in this field has clearly exemplified the means by which digital tools for information search mediate students' learning activities.

Another significant finding of this study concerns the way students are challenged by the complexity of information on the Internet. For example, when they discuss the features that can define a reliable source and they navigate through multiple *layers of information* on the web, they encounter a *never-ending regression of scientific texts*, and they are struggling to find the actors behind the text. Therefore, this is not just a complexity of the controversies, and of different views and arguments, but it says something about another complexity how the Internet works with layers of links and data-sources (cf. Lemke, 2006). In the view of this, design and function of the tools for controversy mapping are actually facilitating students' work in this process by enabling them to find new ways to visualize and to articulate science. Latour (2004) calls this innovative way to visualize science a move "from matters of fact to matters of concern", while Venturini (2012) refers to this affordance as "digital mediation traceability" where the tools trace and aggregate the information on public debates. Nonetheless, the results of this study have shown that the use of such tools imply a much more complicated process. So, in some ways, they do facilitate the students' work, but in other ways, they complicate it as well. Overall, the tools do open up possibilities for learners doing information-search, but they also make the activities a lot more complex.

As emphasized by Alexandersson et al (2007), the borderline between information search and learning is rather thin, and therefore, the two processes go hand-in-hand. The means by

which students use, collect and deliver scientific information while using specific digital tools for inquiry about moral-democratic-political debates also illustrate how their ways of learning are transformed by their view of what knowledge is, and how it is formed (cf., Säljö, 2010). By doing so, students themselves act as mediators, and as they create the maps, they also re-present the controversies with the help of the digital method. Consequently, they are making the maps for their own learning purpose, but also for a public consumption (to report for others and that they deliver information on the controversies). This again underlines the importance of the role that students have as agents in creating the maps.

In this research, compared to other research that explore students' information search on the Internet (e.g. Alexandersson & Limberg 2012; Francke et al, 2010; Lilja, 2012; Lundh et al, 2012; Sundin, 2011) I see is that the use of controversy mapping, as an innovative digital method entails a very complex process. Nonetheless, in their activities of information search students actually succeed in doing something with the digital tools. Moreover, they not only learn something about their own topic, but they learn about the challenges we enter when we need to be informed about open-ended controversies. Such topics are much more complex than ordinary school subjects since they include aspects that are contested. Instead, students acquire a more generative understanding of how knowledge is created and they need to make valid assessments and valid decisions. This is something interesting for schooling because it also relates to the responsibility that schools have in educating citizens to support students to be part of society.

Conclusion

The relevance for using controversy mapping to do information seeking on the Internet calls for attention in the Swedish upper secondary education due to the potential that the applied digital tools imply for learning. Namely, these tools help students to visualize results of on-line information search and of web-source validation. This is especially interesting in the western world where educational practices rely heavily on digitalized information. Consequently, the empirical material used in this study contributes to knowledge about how practices of web-based information search and evaluation of web-sources are concerned when new digital methods enter established school practices.

In a broader context, the pedagogical relevance of the current study e.g. teacher education and educational work- is that it aims to bring forward how different digital tools interact with the students' learning and the educational arrangements that are required in this work. The

findings may inform teachers on how they can organize learning situations at school where students work with sophisticated digital tools. Moreover, in a democratic society it is also important that schooling supports students in their learning to navigate their way through a sea of different voices, arguments, evidence and methods to make relevant meaning of the sources they encounter. As a result of the data analysis in the current study, the digital tools used for mapping controversies of socio-scientific matters may challenge students' ways of searching and evaluating information. Nonetheless, the tools also provide support for students to understand better what it means to work with digitized information, and they also underpin students' enhanced understanding of how to approach controversial issues in science.

The appropriation of new digital tools in education is still a field of knowledge that needs more empirical studies. The findings from my study aim to inform educational and learning practices by indicating both the potential and the challenges posed by the use of technologies for the field of information search. Considering the significance of digital tools for information literacy the findings of this study have revealed some interesting aspects of how the appropriation of such tools interplays with students' information seeking and web-source evaluating strategies, during activities that address complex socio-scientific issues.

This is only a small case study, and so it does not aim to make any large generalizations. However, as indicated by the findings, the possibilities and challenges that new digital tools imply for learning about controversies of socio-scientific issues is a crucial matter for today's schooling in a society prevailed by digitalized information. Therefore, it requires more research in order to inform educational and learning practices.

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Appendices

Appendix 1. Transcription conventions – derived from Hutchby & Wooffitt (1998)

[	point of overlap onset
]	point at which utterance terminates
(0.0)	lapsed time in tenths of a second
,	comma indicates a gap between utterance which is too short to time, more like a very short pause
(.)	a gap of approximately on tenth of a second, noticeable pauses
Word	underline indicates speaker emphasis
!	animated and emphatic tone
?	rising intonation or inquiring intonation
:	prolongation of immediately prior sound
::::	the more colons the longer the sound is drawn out e.g. ye::ar
◦	relatively quieter than surrounding talk
( )	inability to hear what was said
Word	indicates a fading away, often after ◦
(( ))	transcribers descriptions rather than or in addition to transcriptions
-	indicates interrupted talk

Appendix 2. Transcribed excerpts in Swedish

Excerpt 1

01. Ana: ((Ana turns her laptop half-way towards Vicky and reads out loud a statement)) ja just det, där var det där också. forskning visar att hpv vaccin förstör äggstockarna och kan leda till (sterilitet)]
02. Vicky: [nej, men det känns så konstigt (.) ((casts a quick glance at Ana's monitor, and reacts in a nearly audible voice)) ◦men hitta för källan
03. Ana: men det var en (.)
04. Vicky:() men alltså i fall det är onödigt]
05. Ana: [men vad var det här för källa? här står det nåt
06. Ana: men här. här står det så här american journal of reproductive immunology. studien (.) just det (.) här står det. fosk (.)den här heter kost (.) sidan är kostdemorkati nånting (.) ((Ana turns her laptop more towards Vickywho leans towards it for a quick moment. Ana fingerpoints at an embedded hyperlink with a title in English))
07. Vicky: men vad hette den källan?
08. Ana: oj, ska vi se (.) den hette (.) där ((Ana fingerpoints at the name of the website, http://www.ncbi.nlm.nih.gov/pubmed/23902317 which is a scientific database. Vicky looks at Ana's monitor))
09. Vicky: men jag har tänkt den, den med kostdemokratin (.) vad var den studie?
10. Ana: ah, forskning visar att] ((although the page open on the screen is the American scientific database, when

she reads out loud, Ana is pointing at another tab, namely to a Swedish webpage, kostdemokrati.se))

11. Vicky: [gå in på den (.)där ((Vicky points with her finger to Ana's monitor, more precisely, on the tab for kostdemokrati.se. Ana switches to that, and then Vicky points into the text.))
12. Ana: jaha (.) american journal of reproductive immunology ((Ana reads this from kostdemokrati.se, which is a Swedish website, and she struggles somewhat with pronouncing the last word))
13. Vicky: ((Vicky looks carefully at Ana's monitor as she types this name into her own google search, she is spelling the words aside))
14. Carl: trick or try! ((seems to think out loud or to simply read something out loud to himself))
15. Ana: ((Ana switches to the tab for the American database, which contains an abstract of a study: problem method-results conclusion. She sighs deeply and holds unto her head)) ska man förstå det här också? Det står där väl en massa (.) problem (.) men gud, ja fattar inte vad står det (.)

Excerpt 2

01. Ted: dem här trådsider, till exempel som flashback () men frågan är: är det sån vi pratar om?
02. Vicky: alltså det är ju inte fakta eller så-]
03. Ana: [fakta?]
04. Ted: [det är ju åsikter
05. Vicky: a:::a] ((with an intonation that reveals skepticism))
06. Ana: [fast-]
07. Ted: [det är väldigt, väldigt mycket åsikter
08. Ana: men den är ju jätte (.) man kan säga opartisk i så fall ((Ana makes quotation marks in the air with her

fingers when she utters the word opartisk))

09. Ana: alltså det är-
10. Ted: ((turns his laptop so that Ana can see his monitor))
11. Ana: vad är det för nåt?
12. Ted: fakta är väl att va opartisk mot ◦nåt (.)
13. Ana: ((leans forward to read into Ted's page))
jaha, så du menar just flashback typ?
14: Vicky: du kan ju hitta olika sån här blog åsikter, det finns ju på såna debatter () alltså såna oseriösa (.) alltså om nån säger nånting säg det så att det är ju inte vinklat, tycker jag (.)
15. Ana: men, men, alltså, sådana åsikter (.) man kan ju ha med i så fall
16. Vicky: här (.) lands (.) jag hittar en typ debattartikel här (.) aftonbladet (.) men- ((she reads out loud from the article)) landstingspolitikern Jessica Ericsson vill att pojkar, män som har sex med män ska få HPV vaccin (.) ö::: blablabla (.) det är ju ganska logiskt.
((the pronunciation of the word aftonbladet is combined with a skeptical tone and frowning, followed by an abrupt conjunction, which shows that Vicky has the idea that debates and newspapers can be biased))

(0.16)

Excerpt 3

01. Tom: vår grupp, vår grupp har gjort en geografisk indelning(.) här, här är ju liksom]
02. Josh: [här, här är ju språk med]
03. Tom: a::a jojo, men det är ju, det känner jag också ((points at his own map))
04. Tom: ((makes a circle in the air with his pen, right above certain parts of his map)) här har vi mycket svenska o här har vi mycket av världen o USA liksom mestadels

o även England

05. Josh: jaha, har ni haft olika sökord på de områden ni °var? Ni har sökt både på engelska och svenska på samma ord eller?

06. Emma: ((points at Tom's and Josh's maps)) det är nog det som är skillnad mellan våra och]

07. Tom: [precis, för ni, för era är ju mer organisatoriskt indelat]

08. Ana: [men:öö]

09. Josh: [vi har, vi har, vi har engelskt sökord (.) bara]

10. Tom: [bara?

11. Josh: ja, inte sökt nåt svenskt

12. Tom: okej

13. Josh: bara]

14. Ana: [°okej

15. Josh: vi tog, eller man märkte att information, alltså hur mycket information som var tillgänglig var (.) alltså skilde sig jättemycket om vi sökte på electronic waste eller sökte på (.) a::a elektroniskt avfall eller nåt a:a

16. Tom: men det hade ändå (.) jag skulle kunna tro (.) så att (.) det antar jag bara (.) men att (.) ni skulle sökt på lite mer svenska grejer så skulle den förmodligen också sen geografisk]

17. Josh: [a::a det är synlig säkert]

18. Tom: [då man upplever i alla fall att svenska företag är lite mer måna om att (.) att återvinna eller att] ((he is cut off by Josh))

19. Josh: [a::a det skulle ju kunna va, nej men det skulle ju kunna va så om man (.)om man sökte på engelska o (.) o svenska (.) så kanske den svenska källan efter stod i koppling till organisationerna]

20. Tom: [jag är med]

21. Josh: [och så skulle det amerikanska kanske komma lite på sidan av (.) det här är liksom (.) det här är (.) det här är mycket amerikanska sidor o så